Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Loads (TMDL)

for

Big River,
Flat River Creek and
Shaw Branch

Jefferson, St. Francois and Washington Counties, Missouri

Completed: September 25, 2008
Approved: March 24, 2010

Phased Total Maximum Daily Loads (TMDLs)
For Big River, Flat River Creek and Shaw Branch
Pollutants: Lead, Non-Volatile Suspended Solids (NVSS) and Zinc

Name: Big River
Name: Flat River Creek
Name: Shaw Branch

Location: From the mouth of Big River where it joins the Meramec River near Eureka in Jefferson County, to near Desloge in St. Francois County, Missouri


State map showing location of watershed

Hydrologic Unit Code (HUC): 07140104

Water Body Identification (WBID) numbers and Missouri Stream Classifications[1]:

2074—Big River	P
2080—Big River	P
2168—Flat River Creek	C
2170—Shaw Branch	C

Beneficial Uses[2] common for all impaired segments (See Section 2 for more detail):

- Livestock and Wildlife Watering
- Protection of Aquatic Life (Warm-Water Fishery)
- Human Health Protection (Fish Consumption)

Length of Impairments, Pollutants and Sources:

2074—Big River	53 miles for Lead from Old Lead Belt Abandoned Mine Lands (AML)
2080—Big River	40 miles for Lead and NVSS (Non-Volatile Suspended Solids[3]) from Old Lead Belt AML
2168—Flat River Creek	5 miles for Zinc from Elvins Tailings Pile
2168—Flat River Creek	5 miles for Lead and NVSS from Old Lead Belt AML
2170—Shaw Branch	2 miles for Lead and NVSS from Federal AML

[1] For stream classifications see 10 CSR 20-7.031(1)(F). Class P streams maintains flow even during drought conditions. Class C streams may cease flow in dry periods but maintain permanent pools, which support aquatic life.
[2] For beneficial uses see 10 CSR 20-7.031(1)(C) and Table (H)
[3] The impairment was changed for the 2002 303(d) list from sediment to Non-Volatile Suspended Solids (NVSS). NVSS results from soil erosion or erosion of mine waste materials or stockpiles and includes silt, sand and gravel. The new listing gives a clearer picture of the specific pollutants affecting the water.

Location of Impaired Segments:
2074—Big River NW ¼ Section 18, T43N, R4E (mouth) to Survey 3166, T40N, R3E
2080—Big River Survey 3166, T40N, R3E to Section 33, T37N, R4E
2168—Flat River Creek Survey 83, T37N, R5E (mouth) to NW ¼ Section18, T36N, R5E
2170—Shaw Branch NE¼ Section 7, T36N, R5E (mouth) to SW ¼ Section 20, T36N, R4E

TMDL Priority Ranking:
2074—Big River High
2080—Big River High
2168—Flat River Creek Medium for zinc , High for lead and NVSS
2170—Shaw Branch Medium

1.0 BACKGROUND AND WATER QUALITY PROBLEMS

1.1 Geography
The Big River is located in east-central Missouri and is a major tributary to the Meramec River. Its headwaters are in the St. Francis Mountains in Iron and Washington counties. The river drains 974 square miles in parts of six counties, and it flows 138 miles east and north to join the Meramec River near Eureka, Missouri. Ninety-three of those miles are listed as impaired by lead, zinc and NVSS. Flat River Creek is a tributary to Big River and totally contained in St. Francois County. It flows into Big River near Rivermines, has a watershed of 49 square miles and is about 12 miles long. Shaw Branch is a tributary to Flat River Creek. It is only two miles long with a watershed of 5.6 square miles.

1.2 County Origins[4]
Jefferson County was organized December 8, 1818, (effective January 1, 1819) from St. Louis and Ste. Genevieve counties. The county was named for Thomas Jefferson, third President of the United States. Saint Francois County was organized December 19, 1821, from Jefferson, Ste. Genevieve and Washington counties and named for the St. Francis River. The early French probably named the river for St. Francis of Assisi, founder of the Franciscan Order. Washington County was organized August 21, 1813, (effective November 1, 1813) from Ste. Genevieve County and named for George Washington, first President of the United States.

1.3 Historic[5] and Present Day Land Use
Pre-settlement conditions indicate that Ozark uplands were mostly prairie and oak savannah, while thick deciduous and pine forests dominated steep valley slopes and bottoms. Early settlers cleared trees off valley bottoms and uplands for pasture and row crops. From 1880 to 1920, the Ozarks were subject to heavy timber cutting, leaving large expanses of eroding uplands and valley slopes. This was followed by increased pasture grazing and row cropping. Woodland grazing and seasonal

[4] From the state archives at: http://www.sos.mo.gov/archives/history/counties.asp. Only the counties that contain or border the impaired segment are described.
[5] Missouri Department of Conservation basin plans: http://mdc.mo.gov/fish/watershed/big/landuse/

burning became popular, further increasing soil erosion and suppressing young trees. Cutting of the second growth forest began in the mid-1950s (Jacobson and Primm 1994).

Current land use is based on data from 2000 (30-meter resolution), obtained from Thematic Mapper imagery. Overall, in the Big River Watershed, 68 percent of the land is forested, 23 percent is grasslands, four percent is urban and two percent is row or close grown crops. The rest is barren lands (mine tailings, chat piles, etc.) and open water. See the land use maps in Appendix A.

1.4 Soils

There are many different soil types along the Big River, whose watershed covers over 970 square miles. There are also numerous pits, quarries and tailings piles. Tailings are very fine grained and are a result of the milling process. Two different milling processes were historically used. The wet milling process, which is still used today, produces very fine-grained particles in a slurry (mixed with water). These tailings are impounded in dammed ponds. The dry milling process left behind huge piles, 50 to 250 feet high and 30 to 100 plus acres in extent. Along the impaired segment of Big River there are six such piles: Bonne Terre, Desloge, Leadwood, Elvins (Rivermines), Federal, and National (Old Lead Belt). For more information on these piles, see the map (Figure1) and Section 8.0 Implementation Plans.

Soils in the bottomlands of the Big River basin are silt loams with slopes of 0-2 percent. They are deep to very deep (greater that 60 inches), well drained and prone to flooding occasionally or frequently. On foot slopes, side slopes and sloping point ridges the soils are also silt loams. They have slopes of 5-14 percent and are moderately well drained. More silt loams are found on upland ridge tops, saddles and points. These have slopes of 2-9 percent and are mostly deep and well drained. The next five soils are listed in order of increasing slope. The Useful silt loam slopes 8-15 percent, is deep and moderately well drained and is found on back slopes and summits. Gasconade flaggy silty clay loam has 9-35 percent slopes. It is shallow and somewhat excessively drained, found on uneven side slopes. Caneyville stony silt loam is a moderately deep, well-drained soil found on side slopes of 14-20 percent. The Goss very cherty silt loam has slopes of 14-35 percent. It is a deep, well-drained soil found on side slopes and point ridges. In contrast, the Rasey very stony sandy loam, which also has slopes of 14-35 percent, is shallow, somewhat excessively drained and is found on side slopes. These last soils have very steep slopes (15-50 percent): Goss very cobbly silt loam is extremely stony and the Sonsac gravelly silt loam is moderately deep and well drained. They are both found on the back slopes of hills. Moko-Rock outcrop complex is extremely stony and the soil fraction (Moko) is very shallow and well drained. The Brussels-Rock outcrop complex is extremely steep (slopes of 35-90 percent) and stony. The Brussels fraction is a very deep, silty clay loam (Allgood et.al.1979).

1.5 Defining the Problem

For nearly 150 years, the state of Missouri has been one of the world's largest producers of lead and zinc metals. Historically, lead and zinc ores were mined, milled by crushing and separation, and transported to smelters throughout the state to be processed into raw metals.

It is common to find lead and/or zinc contamination in soils, groundwater, surface water, and sediments surrounding lead and zinc mines, mills and smelter sites and near transportation corridors. Contamination from mining and milling comes from large piles of mine or mill wastes on the surface, from other process areas and from underground mine workings that penetrate the shallow aquifer. The contamination around smelters comes from dust fallout from the furnace smokestacks, fugitive emissions from the production processes, transportation of concentrate from mills to the smelter and the slag piles. These operations have the potential to produce waste containing high levels of lead, zinc and other metals that may be deposited in surface waters and soils, both on and surrounding the sites.

The impaired portions of Big River, Flat River Creek and Shaw Branch are located in the "Old Lead Belt" region of southeast Missouri. Refer to Appendix B for maps showing the impaired segments. The first authentic record of exploration and settlement in Missouri is in the account of the transactions of the "Company of St. Phillip." Philip Francois Renault, the son of a wealthy iron founder, was the agent and manager of the company organized in France, in 1719. This company was organized for the purpose of gold and silver mining. Instead, Renault's mining company discovered lead ore in the area as early as 1720. For more than 100 years, this area produced nearly 80 percent of the nation's mined lead. The St. Joe Lead Company acquired the site in 1864. In 1869, the use of the diamond-tipped drill allowed mining of lead ore deep underground and led to the rapid development of mines in the area. By 1900, the St. Joe Lead Company was the nation's largest lead producer due to their acquisition of smaller lead companies. This included the Federal Lead Company mine site, the source of the impairment to Shaw Branch. In 1972, St. Joe Minerals Corporation stopped production of lead at this site. The mining complex, along with 8,000 acres of land, was donated to the State in 1976 to be used for recreational purposes. The Federal Mill Complex was developed as the Missouri Mines State Historical Site, and includes large mining equipment and mine buildings.

Letterbooks from the Federal Lead Company indicate environmental pollution was a concern prior to 1913. During the time the letterbooks were kept, 1907-1913, farmers and ranchers along Big River brought a suit against the Federal Lead Company. The suit claimed that lead pollution had harmed or destroyed crops and livestock. By the ending date of the letterbooks, the suit had not been resolved.[6] Lead mining in the Old Lead Belt ceased in 1972, after over eight million tons of lead were mined. Washington County was the world's leading producer of barite before declining in the 1980s. Many of the later large mining operations reworked lands that were previously hand mined for galena (mineral source of lead) or barite. Washington County contains more than 1,000 lead and barite mining, milling, or smelting sites, so tailings from historic Washington County mining may also be impacting the Big River Watershed.[7] By 1978, over 200,000 acres (thirty percent) of the Big River Watershed were affected by mining. Many of those acres have since been reclaimed, but severe problems still exist with lead and sediment contamination in the Big River system.

Figure 1 presents the locations of the various tailings piles referenced in this document. Big River is impaired by erosion of tailings directly from the Desloge pile, from the Leadwood pile via Eaton

[6] University of Missouri at Rolla Web site, R520 – Federal Lead Company, Mining Dept. (Flat River, MO.), Letterbooks, 1907-1913 – Information Sheet. http://web.mst.edu/~whmcinfo/shelf21/r520/info.html
[7] http://www.epa.gov/superfund/sites/narr/nar1768.pdf

Branch and by tailings entering from Flat River Creek. The following impair Flat River Creek: Erosion of lead tailings from the Federal tailings pile (St. Joe State Park), erosion of tailings from the National pile (which adjoins the Flat River Glass Company) and erosion of tailings and discharge of dissolved zinc from the Elvins pile. This erosion has deposited a large amount of the tailings in pools within these water bodies and creates secondary sources of contaminated sediment (see Section 4.2.1). These sediments, which are also referred to as nonvolatile suspended solids (NVSS), reduce the aquatic habitat quality by smothering natural substrates (materials in the streambed). Aquatic invertebrate animals, such as water insects, mussels, crayfish and fish eggs are also smothered. Of particular concern are two native fresh water mussel species, scaleshell (*Leptodea leptodon,*) and pink mucket *(Lampsilis abrupta*). The lower Big River supports declining populations of these federally endangered mussels. Tailings derived sediment and associated metals toxicity adversely affects the aquatic habitat, growth, and reproduction of these endangered species and other species of conservation concern within the watershed.

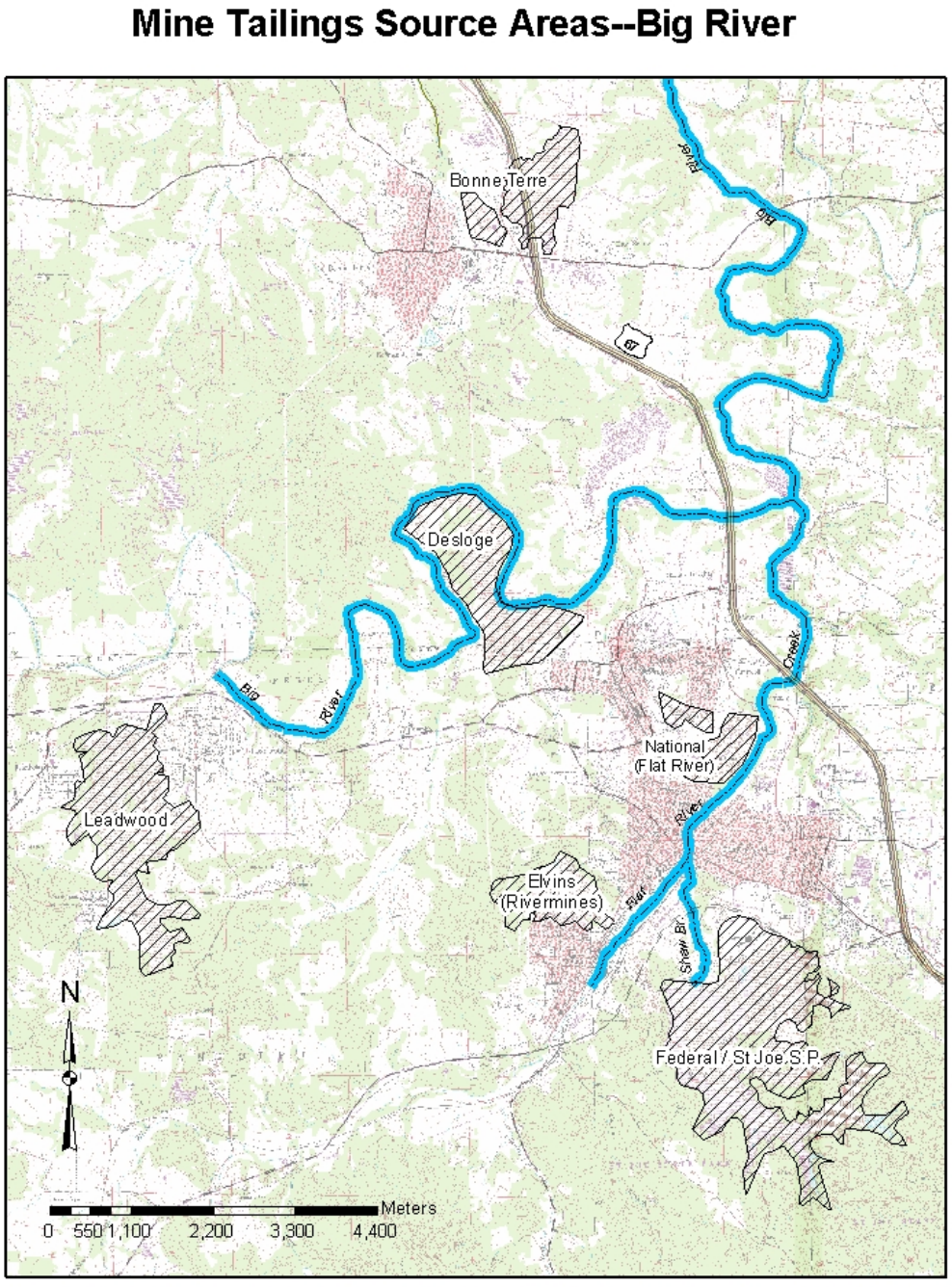
Fish and other aquatic life have accumulated elevated levels of lead in their bodies due to dissolved lead draining from the old tailings. Big River, in St. Francois and Jefferson counties, and the lower six miles of Flat River Creek presently are under a Missouri Department of Health and Senior Services advisory recommending no consumption of sunfish, carp, redhorse or other suckers due to lead contamination in these fish.[8]

In humans, lead primarily affects the nervous system, blood cells and processes for the metabolism of Vitamin D and calcium. Lead can affect the developing fetus during pregnancy and cause lower IQ scores, poor attention levels, hearing, speech and language problems, reading disabilities, reduced motor skills and poor hand-eye coordination in young children. The Agency for Toxic Substances and Disease Register considers blood lead levels over 10 micrograms per deciliter (µg/dL) as toxic. According to the Missouri Department of Health and Senior Services, 11 percent of the children in St. Francois County tested for blood lead levels actually have lead poisoning. Nationwide, the average for lead contamination in children is less than three percent. It is not known how much of the lead contamination in humans in this area is due to consumption of fish as opposed to other possible sources of lead such as eating locally grown vegetables, inhalation of airborne lead or ingestion of lead in paint or in the soil.

As stated above, Shaw Branch is a tributary to Flat River Creek. The upper mile of Shaw Branch was buried under a large tailings pond as part of the milling operation. Subsequent erosion of material from the St. Joe tailings pond has occurred in the lower mile of Shaw Branch, located downstream of the tailings pond. So much sediment has been deposited in this portion of Shaw Branch that the stream channel has been almost completely buried in tailings with only a few pools that support aquatic habitat.

[8]Missouri Department of Health and Senior Services 2007 Fish Advisory. A Guide to Eating Fish in Missouri. http://www.dhss.mo.gov/NewsAndPublicNotices/07FishAdvisory.pdf

Figure 1. Mine Tailings Source Areas – Big River



2.0 DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGETS

2.1 Beneficial Uses

Big River (2074):

- Irrigation
- Livestock and Wildlife Watering
- Protection of Aquatic Life (Warm-Water Fishery)
- Human Health Protection (Fish Consumption)
- Cool Water Fishery
- Whole Body Contact Recreation – A
- Secondary Contact Recreation
- Industrial

Big River (2080):

- Livestock and Wildlife Watering
- Protection of Aquatic Life (Warm-Water Fishery)

Big River (2080), Cont.:

- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation – A
- Industrial

Flat River Creek (2168) and Shaw Branch (2170):

- Livestock and Wildlife Watering
- Protection of Aquatic Life (Warm-Water Fishery)
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation – B

2.2 Uses That are Impaired

- Protection of Aquatic Life (Warm-Water Fishery) [all four segments]
- Human Health Protection (Fish Consumption) [all segments except Shaw Branch]

2.3 Antidegradation Policy

Missouri's Water Quality Standards include the Environmental Protection Agency (EPA) "three-tiered" approach to antidegradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 28, 1975, the date of EPA's first Water Quality Standards Regulation.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than

required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and water of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

2.4 Specific Criteria

2.4.1 Lead and Zinc

Missouri Water Quality Standards (WQS) for metals found in 10 CSR 20-7.031(4)(B)1 state:

> "Water contaminants shall not cause the criteria in Tables A and B to be exceeded. Concentrations of these substances in bottom sediments or waters shall not harm benthic organisms and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded."

And from Table A of the WQS:
Current lead and zinc standards for the protection of aquatic life use are expressed in dissolved form. They are hardness dependent and calculated from the formulas shown below:

Dissolved Lead (DPb)
Acute = $e^{(1.273*\ln(\text{hardness})-1.460448)}*(1.46203-(\ln(\text{hardness})*0.145712)) = \mu g/L$
Chronic = $e^{(1.273*\ln(\text{hardness})-4.704797)}*(1.46203-(\ln(\text{hardness})*0.145712)) = \mu g/L$

Dissolved Zinc (DZn)
Acute = $e^{(0.8473*\ln(\text{hardness}) + 0.884211)} * 0.978 = \mu g/L$
Chronic = $e^{(0.8473*\ln(\text{hardness}) + 0.785271)} * 0.986 = \mu g/L$

Per 10 CSR 20-7.031(1)(Y), the 25th percentile of 262 hardness records taken in the Big River Watershed is 200 mg/L. This hardness value will be used to calculate the lead and zinc criteria:

Lead: 136 and 5 μg/L for acute and chronic respectively.
Zinc: 211 and 193 μg/L for acute and chronic respectively.

The TMDL for metals will be based on chronic criteria and thus aquatic life will be protected from acute and chronic toxicity.

2.4.2 Non-Volatile Suspended Solids (NVSS)

Missouri has no numeric standard for NVSS. Excessive deposits of sediment (in particular NVSS) in waters of the state are interpreted as violations of the general (narrative) criteria of the Water Quality Standards. The general criteria [10 CSR 20-7.031(3)(A), (C) and (G)] state that:

- Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.

- Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.

- Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

2.5 Numeric Water Quality Targets

2.5.1 Lead and Zinc

The water quality targets for metals will be based on chronic criteria and thus aquatic life will be protected from acute and chronic toxicity. Those numbers are 5 μg/L for lead and 193 μg/L for zinc. The department's Water Protection Program, in cooperation with the Environmental Services Program (ESP), is conducting studies in old mining sites throughout the state, including the Big River Watershed, to measure heavy metals in sediment and to assess their probable effect levels (Appendix H). Since no sediment standards appear in state regulations, the criteria here are the probable effect levels (PELs) for heavy metals.[9] PELs are the lowest contaminant level at which an adverse effect upon the aquatic biota could be expected. The results of the studies for relevant water bodies and pollutants are summarized in Table 1.

Fish tissue data collected from Big River and its tributaries can be found in Appendix G. There are no numeric water quality criteria for lead and zinc associated with the Protection of Human Health – Fish Consumption designated use in the Water Quality Standards. There are, however, fish tissue concentrations for these pollutants that have associated consumption advisory levels established by the Missouri Department of Health and Senior Services (DHSS). Fish Consumption advisories are prepared and published annually by DHSS and available on their Web site at www.dhss.mo.gov. Reductions in the quantity of suspended and dissolved lead and zinc within Big River and its tributaries is expected to decrease the concentrations of these metals available to bioaccumulate within resident aquatic species. Implementation of the reductions found in this TMDL to protect the aquatic life designated use are expected to reduce the magnitude and frequency of fish consumption advisories within the Big River Watershed over time.

[9] Ingersoll, C.G., et. al. 1996. "Calculation and Evalualtion of Sediment Effect Concentrations for the Amphipod Hyalella azteca and the Midge Chironomus riparius". J.Great Lakes Res. 22(3):602-623.

Table 1. Levels of Metals in Sediment Grouped by Watershed

Contaminant	WBID	Number of Samples	Number of Samples Exceeding PEL	% Exceed
Lead	2080, 2074	38	25	66%
Lead	2168	65	51	78%
Lead	2170	15	15	100%
Zinc	2080, 2074	38	9	24%
Zinc	2168	65	11	17%
Zinc	2170	15	4	27%
Sediment Guidelines: Probable Effect Level (PEL) Lead = 82 mg/kg Zinc = 540 mg/kg				

2.5.2 Nonvolatile Suspended Solids (NVSS)

There are no NVSS data, but there are 461 records of Total Suspended Solids (TSS) collected in the watershed, not including Turkey Creek below the Bonne Terre Wastewater Treatment Facility.[10] Theoretically, TSS equals volatile (organic) suspended solids (VSS) plus NVSS (mineral, non-volatile). Assuming that the ratio of VSS to NVSS is constant, then NVSS parallels TSS in amplitude (as TSS increases, so does NVSS). Therefore, for the purpose of this TMDL, TSS will be used as a surrogate target for NVSS. A TSS target concentration can be derived from either the 75th percentile of the reference data or the 25th percentile of all existing data, whichever is more appropriate. The data used in these calculations may be found in Appendix F.

2.5.3 Reference Data

There are 53 TSS records collected in the upper watershed above all known tailings during the period from May 1976 to September 1989. These reference data are assumed to represent the natural background of the watershed. Thirty-five percent of these records are below the detection level of 1.0 mg/L. All values below detection were assigned half the value of the detection level. The 75th percentile of the TSS reference data is 5 mg/L.

2.5.4 All Data

Four organizations or programs collected TSS data in Big River Watershed during the period from May 1974 to September 2004. Three different detection levels were used: 1, 5, and 10 mg/L (Tables 2-4), which adds a level of complication to analyzing the data. Data below detection levels were assigned half the corresponding detection level. The 25th percentile of this TSS data set is 1.3 mg/L; said differently, 25 percent of all TSS data collected in the watershed have values at or below 1.3 mg/L. Because of the large number of samples (53%) below detection in the lower 25 percent of the data set, this value is considered unusable as a target concentration. On the other hand, the 75th percentile value of the reference data, 5 mg/L, is more appropriate to use as a target concentration. It considers the below-detection limit samples for position only. In addition, ESP and the United

[10] Turkey Creek is listed for excess biological oxygen demand (BOD) and VSS from the Bonne Terre wastewater discharge. A TMDL was developed for these impairments and approved in January 2005.

States Geological Survey (USGS) collected most of the data to assess this watershed. Their laboratories use detection limits that are equal to or higher than 5 mg/L (ESP uses 5 mg/L and USGS uses 10 mg/L). Therefore, for the purpose of this TMDL, the TSS target is set at 5 mg/L. This target is meant to represent suspended clean sediment free of any pollutants including metals.

Table 2: Existing TSS Data Distribution by Agency and Reporting Limit.

Organization	Detection level (mg/L)	No-detect Representation	Number of Samples below detection	Number of Total Samples	% of data below detection
COESTL	1	0.499	53	273	19%
MDNR-DPHP	1	0.499	18	54	33%
UMR	5	2.499	0	4	0%
USGS	1	0.499	3	104	3%
USGS (since 5/2000)	10	4.99	16	22	73%
TOTAL			90	461	20%

COESTL = US Corp of Engineers – St. Louis Branch.
MDNR-DPHP = Division of Parks and Historic Preservation within DNR.
UMR = The University of Missouri in Rolla.
USGS = US Geological Survey.

Table 3: Dissolved Zinc Data Distribution by Agency and Reporting Limit (2168)

Organization	Detection level (µg/L)	Non-detect indicator	Samples Below Detection	Total Samples	% of Data Below Detection
USGS	3	1.499	1	30	3%
MDNR-DPHP	5	2.499	9	119	8%
	10	4.99	9		8%
	15	7.499	2		2%
	20	9.99	3		3%
	100	49.99	15		13%
MDNR	5	2.499	2	5	40%
UMR	10	4.99	23	94	24%
New Fields	5	2.499	2	11	18%
		Total	66	259	25%

Table 4: Dissolved Lead Data Distribution by Agency and Reporting Limit (2074)

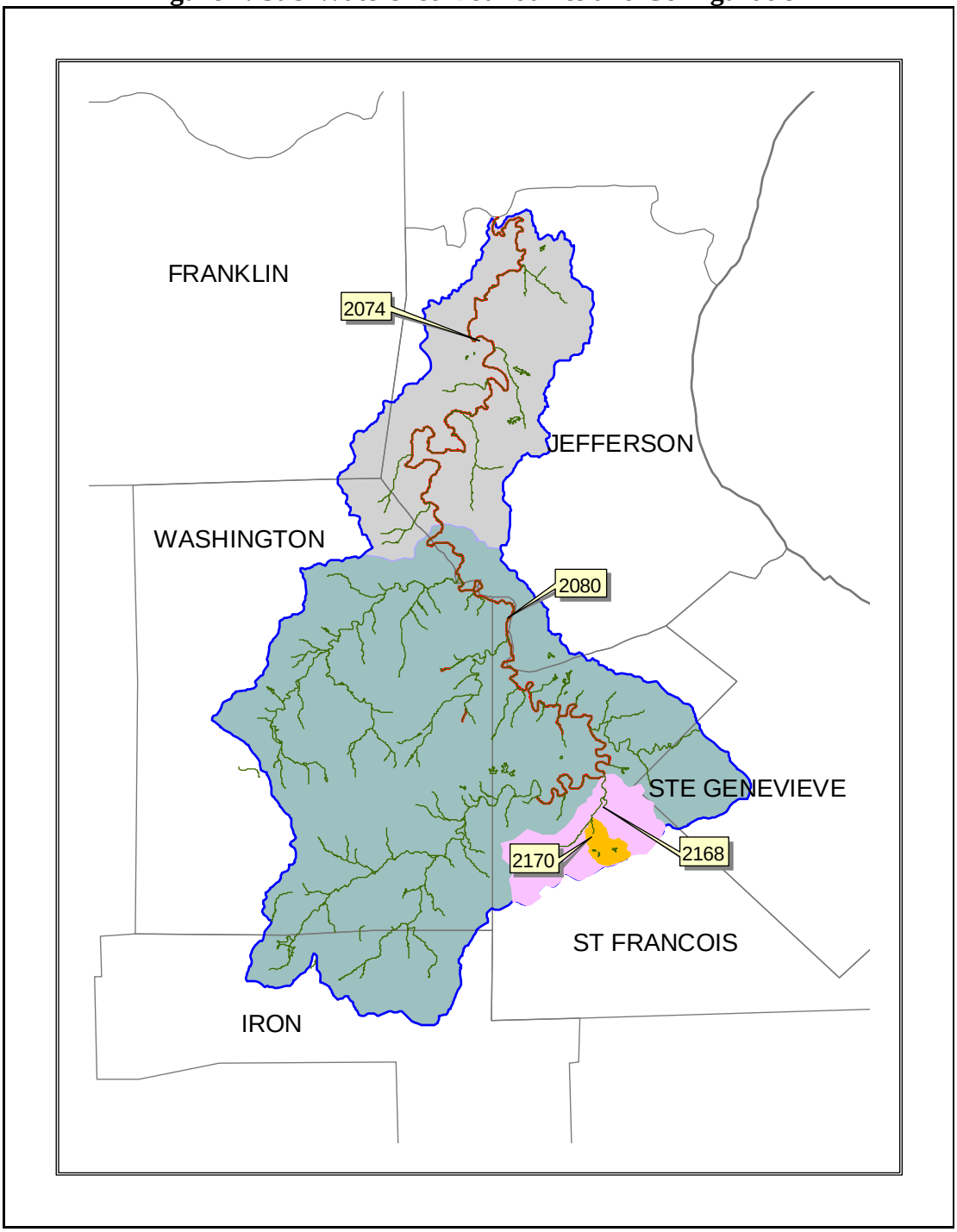
Organization	Detection level (µg/L)	Non-detect indicator	Samples Below Detection	Total Samples	% of Data Below Detection
USGS	1	0.499	5	148	3%
	5	2.499	3		2%
	10	4.99	48		32%
	100	49.99	6		4%
MDNR	0.25	0.12499	9	72	13%
	2.5	1.2499	9		13%
MDNR-DPHP	5	2.499	13	118	11%
	10	4.99	23		19%
	50	49.99	19		16%
	500	249.99	3		3%
UMR	10	4.99	1	82	1%
	50	24.99	32		39%
New Fields, Inc.	1	0.499	3	31	10%
	3	1.499	2		6%
Total			176	451	39%

Table 5: Watershed Area and Sub-Watershed Percentage to the Big River Watershed (2074)

WBID	Watershed Name	Impairment(s)	Hectares	Acres	%
2074	Big River – Mouth	Lead	237,494	586,880	100%
2080	Big River @ USGS 07018100	Lead/Sediment	190,358	470,400	80%
2168	Flat River Creek - Mouth	Zinc/Lead/Sediment	12,724	31,443	5%
2170	Shaw Branch - Mouth	Lead/Sediment	1,450	3,584	1%

Note that each watershed in Table 5 includes everything upstream of the outlet (or bottom of) of that particular basin. For example, watershed 2074 starts at the mouth of Big River and includes the whole Big River Watershed. For a map showing these watersheds, see Figure 2 below.

Figure 2: Sub-Watershed Boundaries and Configuration



3.0 CALCULATING THE LOADING CAPACITY – LINKING WATER QUALITY AND POLLUTANT SOURCES

The Loading Capacity (LC) is the greatest amount of pollutant loading that a stream can assimilate without becoming impaired. It is equal to the sum of the Load Allocation (LA), the Wasteload Allocation (WLA) and the Margin of Safety (MOS) and can be expressed as an equation:
LC = LA + WLA + MOS

3.1 Modeling approach

Figure 2 shows the four watersheds under study (WBID: 2074, 2080, 2168, and 2170). The modeling approach for the impaired segments contained within these watersheds consists of creating a load duration curve at the outlet of each of the four impaired segment's watersheds and determining the TMDL for each pollutant of concern at every flow probability. A TMDL is the product of the standard of concern (in mg/L), the expected flow at the corresponding probability (as ft^3/s) and a conversion factor (2.45). The resulting load is expressed in kilograms per day (1 kg = 2.2 pounds). Because lead and zinc standards are hardness dependent and hardness varies over time and location, a unique hardness value was selected (See Specific Criteria section above) to calculate the target concentration.

Existing load is calculated from flow and concentration records from the same day and site and is plotted against the TMDL curve based on their flow probability and corresponding plotting position (Figures 3 - 10). For graphical clarity, only data collected from sites on the impaired segment (main stem) and having flows greater than or equal to the minimum flow at the outlet of the watershed are plotted on the graph. Because some data have been collected above the outlet, where flow is expected to be lower, some actual observed flows are below the minimum flow calculated from historical outlet flow data. These data points do not plot correctly on the following curves and were eliminated from the graph but not the analysis.

3.2 Synthesis of Flow Data

Baseflow is that part of a stream discharge that is not attributable to direct runoff from precipitation or snow melt; it is usually sustained by ground water (American Meteorological Society). Baseflow for this TMDL was estimated using an automated baseflow program (Arnold et al, 1999).

When flow was not reported with water quality data, a synthetic flow value was calculated. Outlet flow for WBID 2074 of the Big River Watershed was synthesized using USGS 07018500 flow data. This gaging station is at Byrnesville, Missouri, which has a watershed of 917 square miles. The entire Big River Watershed is 955 square miles. By applying a factor of 1.04 (which represents the ratio of the relative watershed sizes) to data from the Byrnesville station, outlet flow for the entire watershed was estimated.

Outlet flows for Flat River Creek and Shaw Branch were derived from comparing flow and watershed areas with USGS 07017200 near Richwoods. Factors of 0.28 and 0.032 were used for Flat River Creek and Shaw Branch, respectively.

When flow data was missing for water quality sites, outlet flow is assigned to the site. This results in over-estimation of the load, since load is the product of flow and concentration and flow at the assigned watershed outlet is greater than the actual unrecorded flow. This conservative assumption is a part of the Margin of Safety required in all TMDL analyses.

3.3 TMDL and Existing Loading for Pollutants of Concern

In general, loads observed below baseflow are attributable to point source discharges and groundwater seepage. Loads observed above baseflow are attributable to seepage, point sources and precipitation-generated runoff (nonpoint sources).

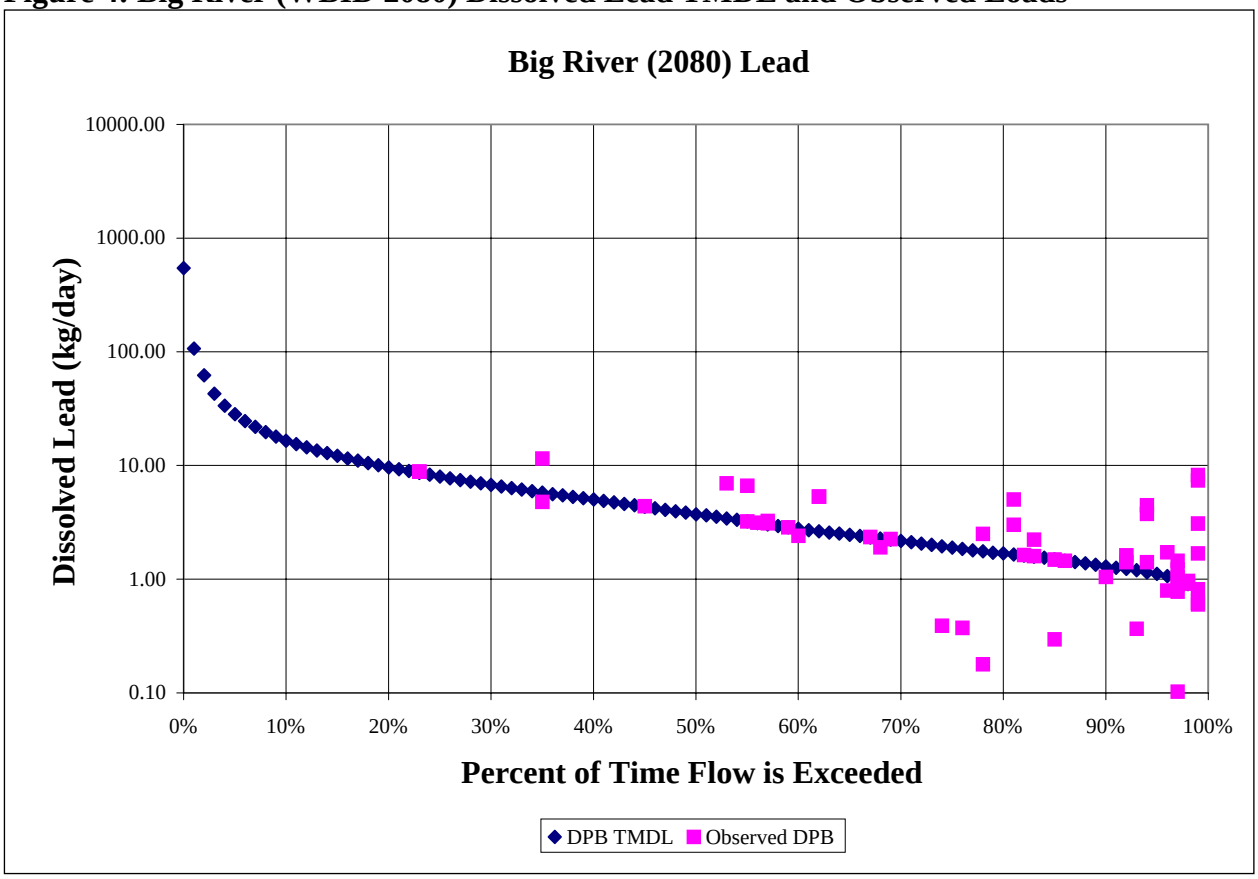
Figures 3 – 10 on the following pages present TMDL and existing loading for the Big River, Flat River Creek, and Shaw Branch watersheds. Tables located below each figure provide TMDL and existing loading values for the pollutant of concern and the reductions required to achieve TMDL loading targets under different flow regimes. Section 3.4 of this document details the percent reduction of the existing loading necessary to meet the TMDL loading targets for each of these watersheds.

Figure 3: Big River (WBID 2074) Dissolved Lead TMDL and Observed Loads

Fifty-five percent of observed dissolved lead data from the Big River 2074 watershed exceeded the target concentration of 0.005 mg/L. Only samples collected from WBID 2074 with flow value greater than or equal to 2.77 m^3/s (98 ft^3/s) were plotted in Figure 3.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	122	1.5	11	86%	9.5
90%	147	1.8	1.5	0%	0
70%	246	3	2.9	0%	0
50%	433	5.3	37.9	86%	32.6
30%	751	9.2	10.3	11%	1.1
10%	1956	23.9	170	86%	146.1
5%	3297	40.3	24.6	0%	0

Figure 4: Big River (WBID 2080) Dissolved Lead TMDL and Observed Loads

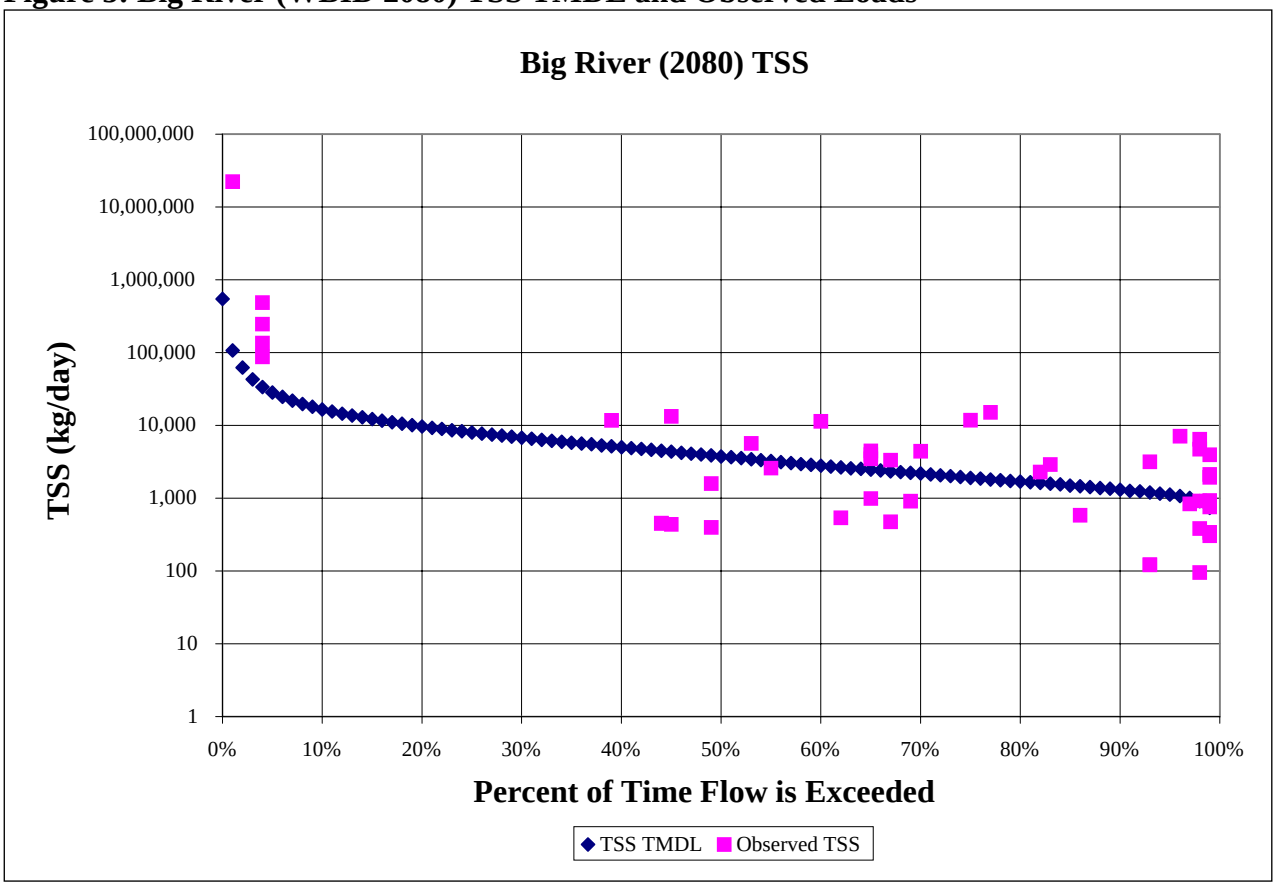


Out of 396 dissolved lead samples in this sub-watershed, 232 (59 percent) exceeded 5-µg/L concentration. Only data collected from this stream segment (WBID 2080) and corresponding to flows greater than or equal to 1.7 m^3/s (60 ft^3/s) are plotted on Figure 4 to contrast observed load and the TMDL.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	91	1.11	7.56	85%	6.5
90%	106	1.3	4.26	69%	3.0
70%	178	2.18	3.93	45%	1.8
50%	305	3.74	6.78	45%	3.0
30%	552	6.76	10.84	38%	4.1
10%	1350	16.54	8.83	0%	0
5%	2310	28.3	ND	---	---

ND – No data for flow range

Figure 5: Big River (WBID 2080) TSS TMDL and Observed Loads

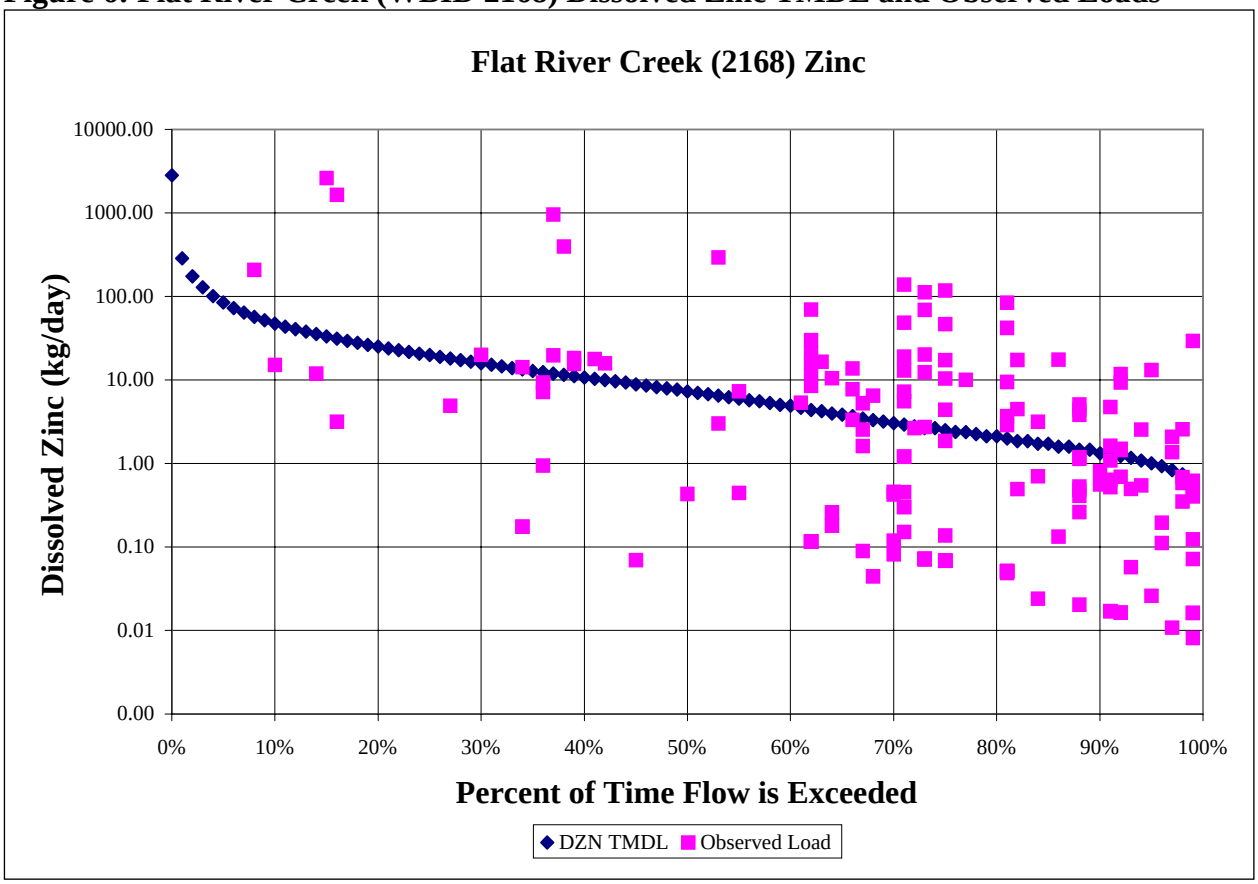


The observed TSS loads shown on Figure 4 correspond to data collected on WBID 2080 and coincide with flows greater than 1.7 m^3/s (60 ft^3/s). However, there are 428 TSS samples collected upstream of segment 2074 [from 2080, 2118, 2168, 2177, and their tributaries] among which 180 (42 percent) are greater than 5 mg/L.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	91	1115	6674	83%	5559
90%	106	1299	2850	54%	1551
70%	178	2181	14244	85%	12063
50%	305	3736	8506	56%	4770
30%	552	6757	12762	47%	6005
10%	1350	16538	ND	---	---
5%	2310	28298	17889425	99%	17782727

ND – No data for flow range

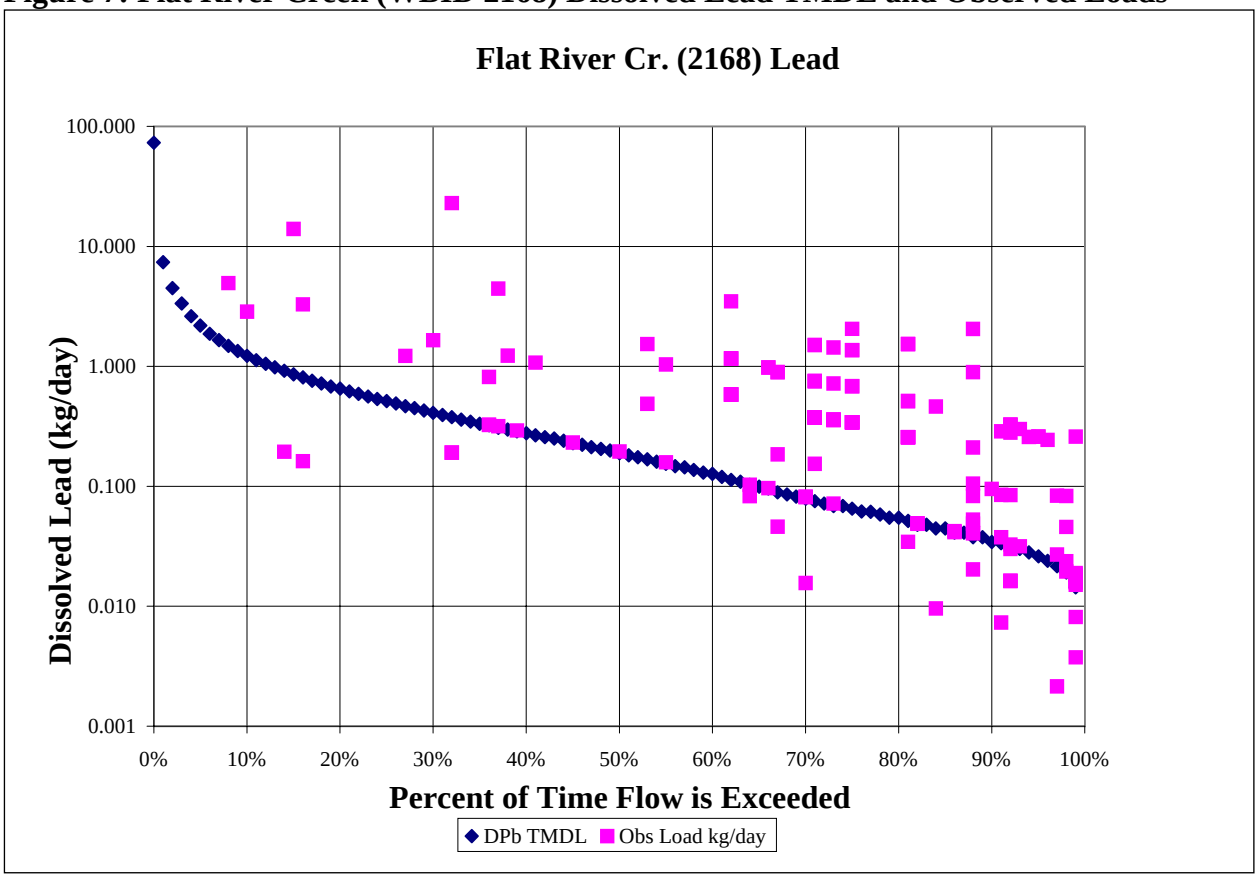
Figure 6: Flat River Creek (WBID 2168) Dissolved Zinc TMDL and Observed Loads



Out of 259 dissolved zinc records collected in Flat River Creek Watershed, 109 (42 percent) reported dissolved zinc concentrations greater than the 193µg/L target concentration. Of the 259 records, 151 samples reported flows greater than 0.033 m^3/s (1.18 ft^3/s) and are plotted in Figure 6.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	2.13	1.01	12.65	92%	11.6
90%	2.8	1.32	9.45	86%	8.1
70%	6.44	3.05	76.8	96%	73.8
50%	15.4	7.28	49.9	85%	42.6
30%	33.6	15.89	563.7	97%	547.8
10%	100.24	47.4	2379.6	98%	2332.2
5%	179.2	84.7	208	59%	123.3

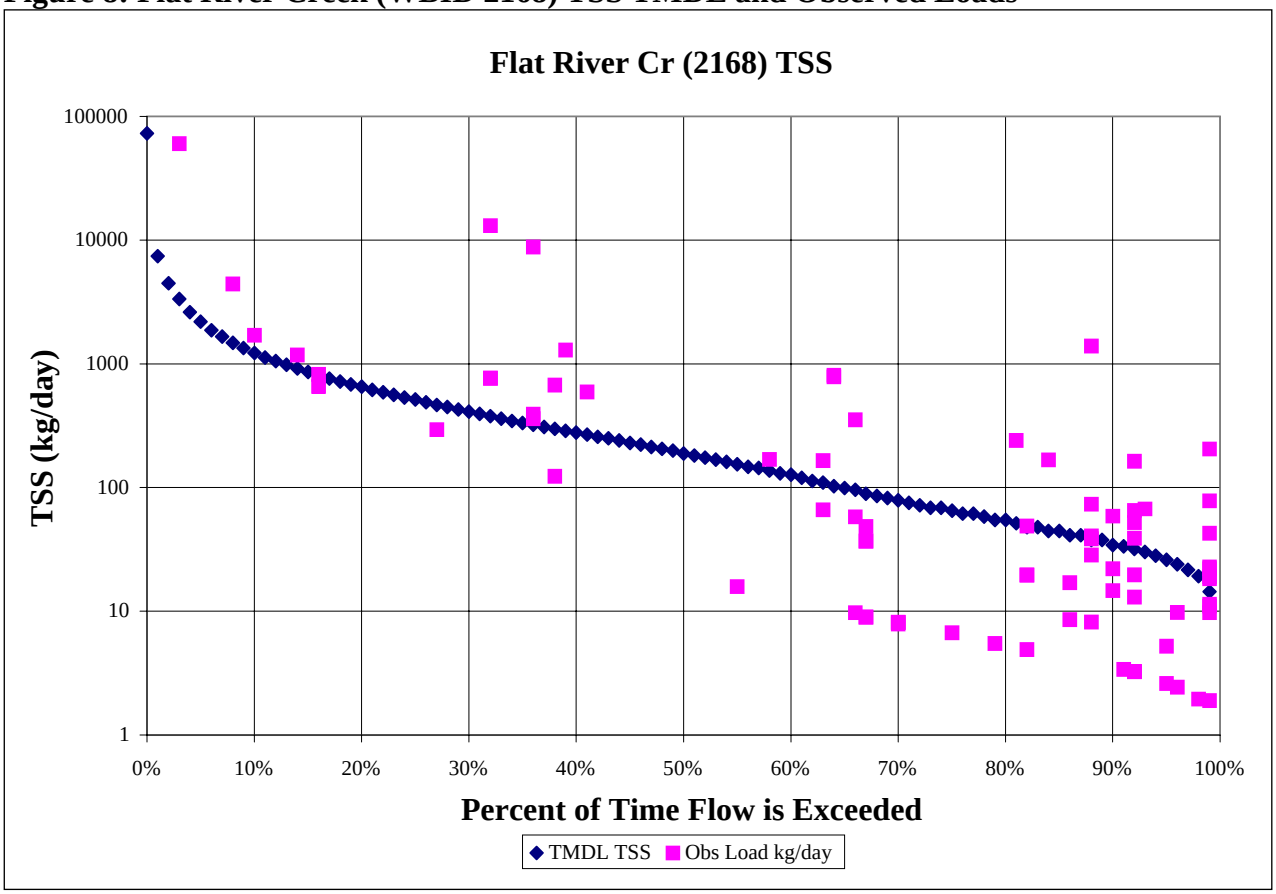
Figure 7: Flat River Creek (WBID 2168) Dissolved Lead TMDL and Observed Loads



Out of 237 dissolved lead records for the Flat River Creek Watershed, 158 (67 percent) exceed the dissolved lead target of 5µg/L. Of that, 151 records report flow greater than 0.033 m^3/s (1.18 ft^3/s) and are plotted with the load duration curve above.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	2.13	0.026	0.25	90%	0.224
90%	2.8	0.034	0.33	90%	0.296
70%	6.44	0.079	1.54	95%	1.461
50%	15.4	0.189	1.46	87%	1.271
30%	33.6	0.412	11.88	97%	11.468
10%	100.24	1.228	11.31	89%	10.082
5%	179.2	2.195	4.95	56%	2.755

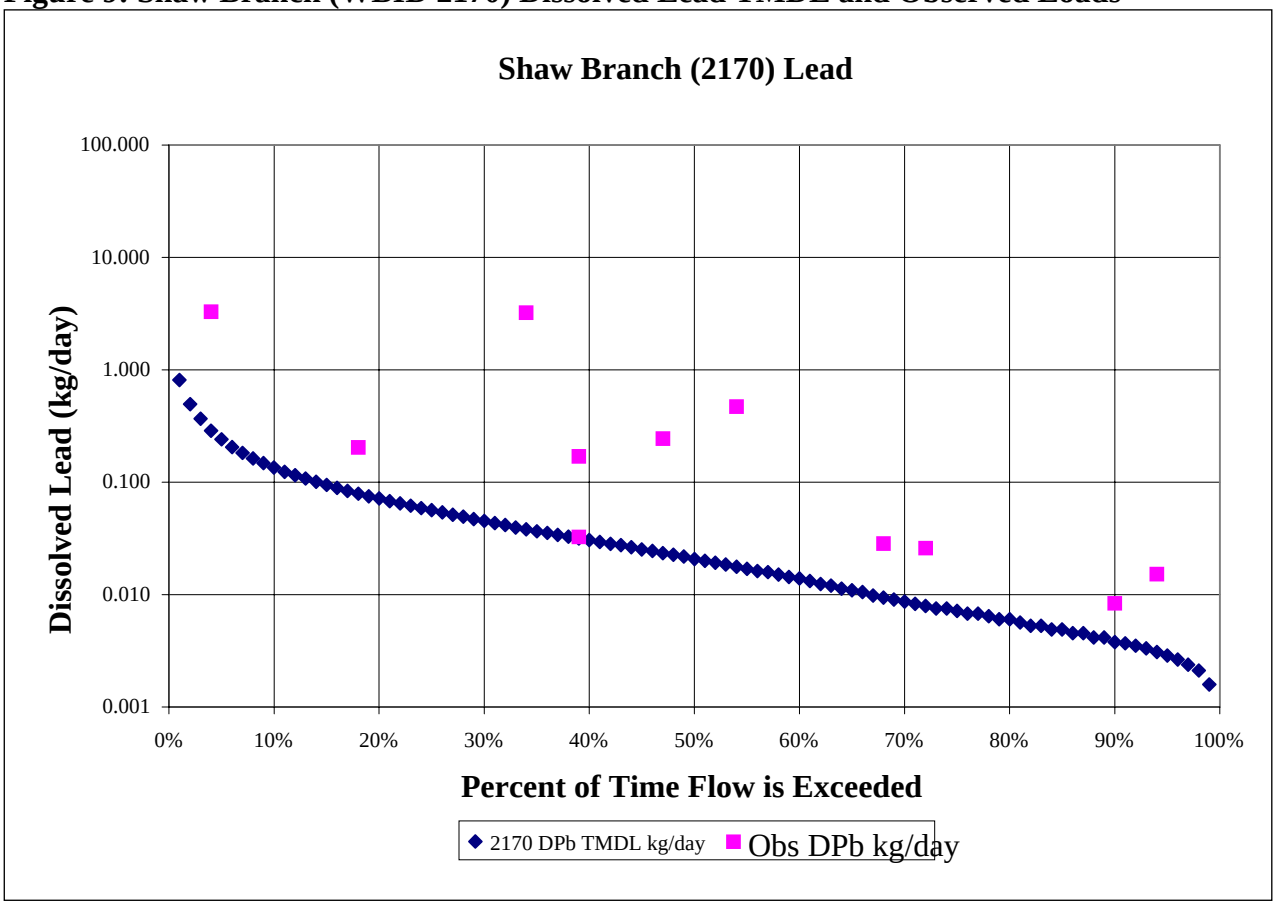
Figure 8: Flat River Creek (WBID 2168) TSS TMDL and Observed Loads



Out of 149 total suspended solids records for the Flat River Creek Watershed, 62 (42 percent) exceeded the 5 mg/L target established for this TMDL. Only records with flows greater than 0.033 m^3/s (1.18 ft^3/s) were plotted on the above figure to illustrate observed load and TMDL.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	2.13	26.1	110	76%	83.9
90%	2.8	34.3	101	66%	66.7
70%	6.44	78.89	298.1	74%	219.21
50%	15.4	188.65	795.3	76%	606.65
30%	33.6	411.6	11195.5	96%	10783.9
10%	100.24	1227.9	3748	67%	2520.1
5%	179.2	2195.2	60368	96%	58172.8

Figure 9: Shaw Branch (WBID 2170) Dissolved Lead TMDL and Observed Loads

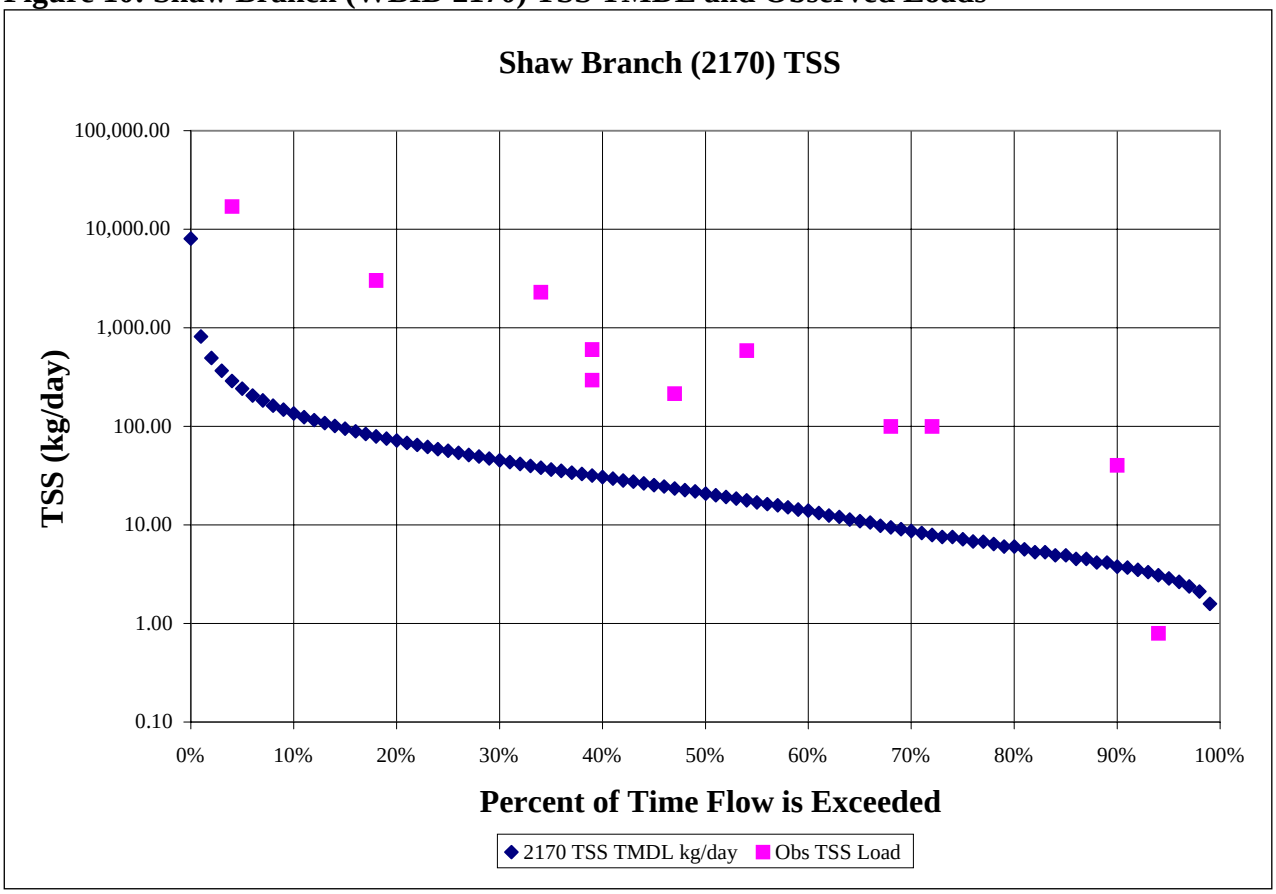


Seventeen out of 19 (89 percent) total records for dissolved lead in Shaw Branch exceed the target concentration of 5 µg/L. Of these records, only data with flow greater than 0.00368 m^3/s (0.13 ft^3/s) are plotted on Figure 9 above.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	0.23	0.003	ND	---	---
90%	0.31	0.004	0.015	75%	0.01
70%	0.71	0.009	0.026	65%	0.02
50%	1.69	0.02	0.449	95%	0.43
30%	3.7	0.05	2.783	98%	2.73
10%	11.03	0.14	0.2	30%	0.06
5%	19.71	0.24	3.3	93%	3.06

ND – No data for flow range

Figure 10: Shaw Branch (WBID 2170) TSS TMDL and Observed Loads



There are 19 total suspended solids records for the Shaw Branch Watershed, 12 of these (63 percent) report TSS concentrations greater than 5 mg/L. Only records from Shaw Branch with flows greater than 0.00368 m^3/s (0.13 ft^3/s) are plotted on Figure 10.

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	Existing Load (kg/d)	Required Reduction	Required Reduction (kg/d)
95%	0.23	2.9	ND	---	---
90%	0.31	3.8	38.3	90%	34.5
70%	0.71	8.7	100.1	91%	91.4
50%	1.69	20.8	563	96%	542.2
30%	3.7	45.3	2040	98%	1994.7
10%	11.03	135	3023	96%	2888.0
5%	19.71	241	17060	98%	16819.0

ND – No data for flow range

3.4 Reductions

Table 6 below details percent reductions of existing loading necessary to meet TMDL loading targets within Big River (WBID: 2074 & 2080), Flat River Creek (WBID: 2168), and Shaw Branch (WBID: 2170). Because the percent reductions listed are the largest calculated values for a given pollutant of concern from Figures 3 - 10, it is expected these reductions will be protective of water quality standards under all flow regimes.

Table 6. Required Reductions of Existing Loading

Water body	Parameter	Required Reduction
2074	DPb	86%
2080	DPb	85%
	TSS	99%
2168	DZn	100%
	DPb	97%
	TSS	96%
2170	DPb	98%
	TSS	98%

4.0 WASTELOAD (POINT SOURCE) AND LOAD (NONPOINT SOURCE) ALLOCATION

4.1 Wasteload Allocations (Point Source Load)

The Wasteload Allocation (WLA) portion of a TMDL is the maximum allowable amount of a pollutant that can be assigned to point sources. The WLA for these TMDLs is set to the lesser of applicable water quality based or technology based effluent limits (TBELs). Additionally, permits can be written to target lower limits if the specific facility is capable of performing better than TBELs. A list of all currently discharging facilities and their design flows can be found in Appendix D.

4.1.1 General and Storm Water Permits

At the time of TMDL development, there were 33 general permits (MOG) and 12 storm water permits (MOR) in the Big River Watershed (Table 7 and Appendix D). General and storm water permits are issued based on the type of activity occurring and are meant to be flexible enough to allow for ease and speed of issuance, while providing the required protection of water quality. Existing inspection data for general and storm water permits within the Big River Watershed suggest these permits are protective of the NVSS, lead, and zinc impairments. Because general and storm water permits within the watershed are not significantly contributing to the water quality impairments, the WLA for these permits is a zero percent net reduction in loading. WLAs for individual facilities covered by general and storm water permits within the watershed are set at current permit limits and conditions.

There are currently two municipal separate storm sewer systems (MS4) within the Big River watershed. Jefferson County Small MS4 (MO-R040052) and City of Farmington Small MS4 (MO-R040004) have outfall locations that discharge to Big River (WBID: 2074) and Flat River Creek (WBID: 2168), respectively. Existing inspection data indicate the outfall locations for these MS4 permits do not currently contribute pollutants of concern to the impaired water body segments. Should future inspection, assessment, or monitoring data indicate these MS4s contribute pollutants of concern to the impaired water body segments, the MS4 permits will be reopened to include requirements sufficient to characterize and reduce impacts from these discharges.

Table 7: General Permits by Watershed

		Watershed number			Total by category
Permit #	**Description**	**2168**	**2080**	**2074**	
MOR80Hxxx	Solid waste transfer		1		**1**
MOR80Cxxx	Motor freight transportation		1	2	**3**
MOR60Axxx	Motor vehicle salvage			1	**1**
MOR24xxxx	Agrichemical facility		2		**2**
MOR23Axxx	Chemical manufacturing	1	1		**2**
MOR22Axxx	Lumber & Wood 2º		1		**1**
MOR040xxx	Storm sewer – municipal MS4	1		1	**2**
MOG821xxx	Land application-septage	1	5	8	**14**
MOG822xxx	Land application-food waste			1	**1**
MOG64xxxx	WTP settling basins	1			**1**
MOG50xxxx	Sand and gravel washing		1	1	**2**
MOG49xxxx	Limestone quarry		8	5	**13**
MOG01xxxx	CA FO		2		**2**
	Total by watershed	**4**	**22**	**19**	**45**

4.1.2 Domestic Wastewater Permits

TBELs are defined in the permit for domestic wastewater treatment systems based on the treatment type. Standard secondary treatment permit limits (such as for mechanical plants) are not to exceed a weekly average TSS concentration of 45 mg/L and a monthly average TSS concentration of 30 mg/L. Equivalent to secondary treatment is limited to a weekly average TSS concentration of 65 mg/L, monthly average TSS concentration of 45 mg/L for trickling filters and a weekly average of 120 mg/L, monthly average of 80 mg/L for lagoons (10 CSR 20-7.015 (8)). Currently there are 92 domestic wastewater treatment facilities in the Big River Watershed. However, treated domestic discharge is not considered to cause or contribute to the impairment of the waterbodies addressed by this document. Thus, the WLA for domestic facilities remains unchanged for NVSS and corresponds to zero percent net reduction in sediment load. This TMDL does not preclude the establishment of future domestic point sources in the watershed.

4.1.3 Non-Domestic Wastewater Permits

Six site-specific, non-domestic wastewater treatment permits have been issued in the Big River Watershed (WBID: 2074). Four facilities are relevant to this study as they discharge pollutants of concern to the impaired water body segments. The pollutant loads in Table 8 reflect estimated

present contributions from these four facilities. The pollutant loads were calculated using the combined design flow of storm water outfalls at the facility and the average reported discharge concentration from the facility discharge monitoring reports. Transport of fine mineral sediment high in lead and zinc from the St. Francois County Environmental Corporation facility (located at the former Desloge tailings pile) and St. Joe State Park (located at the Federal tailings pile) account for much of the point source metals and sediment loading to the impaired segments. It should be noted the mine/mill waste at these facilities is contributing the metal load to the impaired segments and not the non-mining operations. The Vessel Mineral Products and Flat River Glass Operation facilities do not appear to be contributing appreciable amounts of metals and sediment. It should be noted that federal regulations, 40 CFR 122.45(c), require that all permit limits for metals be expressed as total recoverable (TR) metals even though instream water quality targets may be expressed as dissolved metals.

Table 8: Non-Domestic Site-Specific Permits with Current Loads

Watershed	Facility Name	Permit Number	Design Flow (MGD)	TSS (kg/day)	PB TR (kg/day)	ZN TR (kg/day)
2080	VESSELL MINERAL PRODUCTS	MO0001422	0.5	2	**	**
2080	ST FRANCOIS CO ENVIR CORP	MO0108774	6.6	338	2176	3026
2168	FLAT RIVER GLASS OPERATION	MO0098647	1.2	39	**	**
2170	MDNR, ST JOE STATE PARK	MO0097993	8.6	4008	4.1	4

**No permit limit or monitoring requirement for this parameter.

Table 9 (page 28) provides effluent discharge statistics for the above permitted facilities. These data indicate the MDNR, St. Joe State Park (MO-0097993) and St. Francois County Environmental Corporation (MO-0108774) facilities account for much of the metals and sediment loading to the impaired segments. These data also indicate the Vessell Mineral Products (MO-0001422) and Flat River Glass Operations (MO-0098647) facilities are only minor contributors of pollutant loading.

An analysis of facility compliance history, sampling results, permit effluent limitations, and TMDL wasteload allocations (WLAs) will be conducted during reissuance of site-specific permits. All permitted facilities that are identified to contribute sediment and metals loading to impaired segments shall adopt appropriate Best Management Practices (BMPs) to reduce such loading from their storm water outfalls. These facilities must also measure in-stream pollutant concentrations to determine the efficacy of the control measures. Details for individual non-domestic site-specific permits follow.

Vessell Mineral Products – The Vessel Mineral Products facility is in compliance with existing effluent limitations and is not a major contributor of lead to Big River (WBID: 2080). Because the facility is not contributing to the lead water quality impairment, the lead WLA for this facility is a zero percent net reduction in loading.

The Vessell Mineral Products facility is a minor contributor of Total Suspended Solids (TSS) to Big River (WBID: 2080). The facility contributes TSS to the water quality impairment in conjunction with discharges from the St. Francois County Environmental Corporation facility. During low-flow conditions, it is reasonable to allocate the entire loading capacity of a pollutant as wasteload allocations due to the lack of pollutant contributions from precipitation induced surface water runoff. Because the Vessell Mineral Products and St. Francois County Environmental Corporation facilities both discharge TSS to Big River, the two facilities should share the loading capacity for TSS during low-flow conditions. Therefore, the combined TSS wasteload allocation for these facilities during low-flow conditions is 1,115 kg/day.

St. Francois County Environmental Corporation – The St. Francois County Environmental Corporation facility is a contributor of lead to Big River (WBID: 2080). Current total recoverable lead loading from the facility is estimated at 2,176 kg/day based on the calculations from Table 8. An eighty-five percent (85%) reduction in total recoverable lead loading (See Table 6) from the facility would equal 326.4 kg/day. Because the facility wasteload allocation calculated as a percent reduction (326.4 kg/day) is greater than that required by the TMDL load duration curve during critical low-flow conditions (95% flow exceedence, TMDL = 1.11 kg/day), a greater reduction is necessary to meet water quality standards.

During critical low-flow conditions, it is reasonable to allocate the entire loading capacity of a pollutant as wasteload allocations due to the lack of pollutant contributions from precipitation induced surface water runoff. The loading capacity for lead under low-flow conditions will therefore be allocated to the St. Francois County Environmental Corporation facility as a wasteload allocation at 1.11 kg/day.

The St. Francois County Environmental Corporation facility is a contributor of Total Suspended Solids (TSS) to Big River (WBID: 2080). The facility contributes TSS to the water quality impairment in conjunction with discharges from the Vessell Mineral Products facility. During low-flow conditions, it is reasonable to allocate the entire loading capacity of a pollutant as wasteload allocations due to the lack of pollutant contributions from precipitation induced surface water runoff. Because the St. Francois Environmental Corporation and Vessell Mineral Products facilities both discharge TSS to Big River, the two facilities should share the loading capacity for TSS during low-flow conditions. Therefore, the combined TSS wasteload allocation for these facilities during low-flow conditions is 1,115 kg/day.

Flat River Glass Operations – The Flat River Glass Operations facility is in compliance with existing effluent limitations and is not a significant contributor of zinc or lead to Flat River Creek (WBID: 2168). Because the facility is not contributing to the zinc or lead water quality impairments, the WLA for zinc and lead at this facility is a zero percent net reduction in loading.

The Flat River Glass Operations facility is a contributor of Total Suspended Solids (TSS) to Flat River Creek (WBID: 2168). Existing TSS effluent limitations for the facility are a daily maximum of 45 mg/L and monthly average of 30 mg/L. At the facility design flow, daily maximum and monthly average mass limitations are 57.4 lbs/day (26.0 kg/day) and 28.7 lbs/day (13.0 kg/day),

respectively. The TSS TMDL loading capacity for Flat River Creek during low-flow conditions is 26.1 kg/day. The effluent limitations for the Flat River Glass Operations facility are protective of water quality in Flat River Creek and no calculated reduction in loading is required. Therefore, the WLA for TSS at this facility is equal to the existing effluent loading of 26.0 kg/day.

MDNR, St. Joe State Park – Facility is in non-compliance with existing effluent limitations for lead and Total Suspended Solids (TSS). Sediment and metals from this facility are impacting water quality in Shaw Branch (WBID: 2170) and reductions in daily loading are necessary.

Current total recoverable lead loading from the facility is estimated at 4.1 kg/day based on the calculations from Table 8. A ninety-eight percent (98%) reduction in total recoverable lead loading (Table 6) from the facility would equal 0.082 kg/day. Because the facility wasteload allocation calculated as a percent reduction (0.082 kg/day) is greater than that required by the TMDL load duration curve during critical low-flow conditions (95% flow exceedence, TMDL = 0.003 kg/day), a greater reduction is necessary to meet water quality standards.

Current TSS loading from the facility is estimated at 4,008 kg/day based on the calculations from Table 8. A ninety-eight percent (98%) reduction in TSS loading (Table 6) from the facility would equal 80.2 kg/day. Because the facility wasteload allocation calculated as a percent reduction (80.2 kg/day) is greater than that required by the TMDL load duration curve during critical low-flow conditions (95% flow exceedence, TMDL = 2.9 kg/day), a greater reduction is necessary to meet water quality standards.

During critical low-flow conditions, it is reasonable to allocate the entire loading capacity of a pollutant as wasteload allocations due to the lack of pollutant contributions from precipitation induced surface water runoff. However, the MDNR, St. Joe State Park facility encompasses the entire Shaw Branch watershed. All precipitation induced stormwater runoff discharged into Shaw Branch is generated by and from the facility. Therefore, it is reasonable that the entire loading capacity for lead and TSS can be allocated to the MDNR, St. Joe State Park facility as wasteload allocations under all flow conditions (Table 9).

Table 9: Dissolved Lead and TSS Wasteload Allocations for Shaw Branch (WBID: 2170)

Percent of time flow is exceeded	Flow (cfs)	Dissolved Lead WLA (kg/d)	TSS WLA (kg/d)
95%	0.23	0.003	2.9
90%	0.31	0.004	3.8
70%	0.71	0.009	8.7
50%	1.69	0.02	20.8
30%	3.7	0.05	45.3
10%	11.03	0.14	135
5%	66.57	0.82	815

4.1.4 Applicable or Relevant and Appropriate Requirements

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund) (P.L. 96-510) as amended by The Superfund Amendments and Reauthorization Act of 1986 (P.L. 99-499) states, in part, that the State may enforce any Federal or State standard, requirement, criteria or limitation to which the remedial action is required to conform under this Act in the United States district court for the district in which the facility is located.

The Missouri Department of Natural Resources has established Applicable or Relevant and Appropriate Requirements (ARARs) for two discharges within the Big River Watershed. ARARs have been established for the Doe Run, Leadwood – Eaton Tailings Dam (MO-ARAR011) and Doe Run, Lead Belt Material Company (MO-ARAR012) discharges. These ARARs only authorize discharges of storm water from these facilities under the Missouri Clean Water Law and the National Pollutant Discharge Elimination System (NPDES).

Applicable requirements, as defined in 40 CFR 300.5, means those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance found at a CERCLA site. Further, relevant and appropriate requirements means those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not regulated by a state operating permit under the Clean Water Law, nor specific to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems, or situations sufficiently similar to those encountered at the CERCLA site and are well suited to the particular site.

Missouri was granted NPDES authority by the Environmental Protection Agency in 1974. The State thus has its own laws and pursuant regulations contained in the Missouri Clean Water Law (Chapter 644, RSMo) and the Code of State Regulations (10 CSR 20-6, 20-7, and 20-8).

The Doe Run Corporation submitted permit equivalent applications to the department with the understanding that the Water Protection Program would develop appropriate water quality limits and requirements. The Water Protection Program reviewed state laws and regulations to determine and establish the ARARs found in MO-ARAR011 and MO-ARAR012. These ARARs are not a permit; however, their intent is to ensure that the discharger complies with the substantive requirements of Missouri's Clean Water Law and Regulations.

The ARARs established for the Doe Run, Leadwood – Eaton Tailings Dam and Doe Run, Lead Belt Material Company discharges include once per month monitoring requirements for Total Suspended Solids (TSS), total recoverable and dissolved lead and total recoverable and dissolved zinc. Discussions with Doe Run Corporation have revealed that although the monitoring requirements are established in the ARARs, the sampling has not yet occurred. Therefore, it is not known at this time whether these ARARs are protective of water quality within the Big River Watershed. The department has requested Doe Run Corporation initiate sampling under the terms of the established ARARs and submit the results to the Water Protection Program.

Review of the sample results will allow the department to determine whether the ARARs are protective of water quality within the Big River Watershed. If the sampling results indicate the ARAR facilities discharge pollutants of concern at levels that will cause or have the reasonable potential to cause or contribute to an in-stream excursion above water quality standards, wasteload allocations will be included in the ARARs to ensure protection of designated uses. Wasteload allocation development will target the TMDL target water quality criteria.

4.1.5 Abandoned Mine Lands and Tailings Piles

Historic mining activity has left abandoned mine workings and tailings piles throughout the Big River Watershed. These locations constitute discrete areas of point source delivery of TSS, zinc and lead to the impaired segments. The following areas are known to contribute pollutant laden runoff of sediment and metals to the impaired segments:

- Erosion of lead tailings from the Federal tailings pond (St. Joe State Park)
- Erosion of lead tailings from the National pile, which adjoins the Flat River Glass Company
- Erosion of tailings and discharge of dissolved zinc from the Elvins pile
- Erosion of tailings directly from the Leadwood and Desloge tailings piles and tailings entering from Flat River Creek impair Big River
- Erosion of tailings from the Bonne Terre pile

Seepage of dissolved metals from the tailing piles listed above represent another potential secondary source of metals contamination to the impaired water bodies. As precipitation infiltrates tailing piles and moves through the subsurface, metals may become dissolved and enter gaining streams within the watershed via the groundwater recharge pathway. At present, the amount and extent of seepage as a secondary source of metals contamination is unknown.

It should be noted, however, that while a WLA has been calculated for point sources, including any unpermitted abandoned mines or tailings piles, any allocation does not reflect an authorization to discharge from an unpermitted point source. Discharging pollutants to waters of the state without a permit is a violation of both state and federal Clean Water Law. Should it become necessary to permit currently unpermitted abandoned mines or tailings piles, those areas must follow the department's permit application and antidegradation processes and will be evaluated in light of this TMDL.

Table 10: Permitted Facilities Discharge Monitoring Report Summary Statistics, 2002-2006

Flat River Glass Operations

	TSS	
	DML 45 mg/L	**AML 30 mg/L**
002	MIN	2
	MAX	21
	MEAN	7.93
	STDEV	3.95
	CV	0.50
	COUNT	51
	XCD	0%

Vessel Mineral Products

	TSS	
	DML 50 mg/L	**AML 25 mg/L**
001	MIN	0.1
	MAX	2.5
	MEAN	1.39
	STDEV	1.11
	CV	0.80
	COUNT	7
	XCD	0%

MDNR, St Joe State Park

	TSS		PBTR		ZNTR	
	DML 10 mg/L	**AML 10mg/L**	**DML 29 µg/L**	**AML 29 µg/L**	**DML 440 µg/L**	**AML 440 µg/L**
002	MIN	7	MIN	0	MIN	0
	MAX	1190	MAX	3689	MAX	1157
	MEAN	231.25	MEAN	211.51	MEAN	170.96
	STDEV	323.48	STDEV	666.79	STDEV	303.17
	CV	1.40	CV	3.15	CV	1.77
	COUNT	30	COUNT	44	COUNT	44
	XCD	**93%**	XCD	**41%**	XCD	14%
003	MIN	0.5	MIN	0.0025	MIN	0.0025
	MAX	44	MAX	250	MAX	719
	MEAN	7.65	MEAN	32.93	MEAN	58
	STDEV	9.71	STDEV	62.52	STDEV	140.3
	CV	1.26	CV	1.90	CV	2.42
	COUNT	21	COUNT	32	COUNT	32
	XCD	**24%**	XCD	**31%**	XCD	3%

XCD: percent of time that reported discharge levels exceed permit limit.
DML: Daily Maximum Limit
AML: Average Monthly Limit

St Francois County Environmental Corporation

	TSS		PB TR		ZNTR	
	DML 80mg/L	**AML 60 mg/L**	**DML 29 mg/L**	**AML 29 mg/L**	**DML 440 mg/L**	**AML 440 mg/L**
001	MIN	5				
	MAX	21				
	MEAN	10.75				
	STDEV	7.59				
	CV	0.71				
	COUNT	4				
	XCD	0%				
002	MIN	4	MIN	108	MIN	167
	MAX	27	MAX	108	MAX	167
	MEAN	15.83	MEAN	108	MEAN	167
	STDEV	11.27				
	CV	0.71				
	COUNT	6	COUNT	1	COUNT	1
	XCD	0%	XCD	**100%**	XCD	0%
003	MIN	6	MIN	66	MIN	74
	MAX	25	MAX	66	MAX	74
	MEAN	12.8	MEAN	66	MEAN	74
	STDEV	7.26				
	CV	0.57				
	COUNT	5	COUNT	1	COUNT	1
	XCD	0%	XCD	**100%**	XCD	0%

4.2 Load Allocations (Nonpoint Source Load)

4.2.1 Nonpoint Source Pollutant Sources

The Load Allocation (LA) portion of a TMDL is the maximum allowable amount of the pollutant that can be assigned to nonpoint sources. Nonpoint sources are diffuse sources of pollutant loading that typically cannot be identified as entering a waterbody at a single location. These sources involve runoff from non-mining areas and may contribute lead and zinc to surface waters as a result of runoff-producing storm events. Some examples include off-site haul and access roads not constructed of waste rock or spent ore from mining areas. When compared to the mine land areas within the Big River watershed, nonpoint sources of lead, zinc, and total suspended solids loading are expected to be minor. Undisturbed and vegetated areas within the watershed are expected to be insignificant sources of lead, zinc, and total suspended solids to the impaired segments.

While nonpoint sources of dissolved lead and zinc are minor or negligible under critical low-flow conditions, historic and legacy lead and zinc within the stream system can be sources of these metals, especially during higher flows. As conservative pollutants, these metals do not degrade and historic lead and zinc can become re-suspended into the water column and carried downstream via natural fluvial processes. Significant metals suspension and re-deposition can occur during and immediately following high-flow storm events. This process allows previously unavailable lead and zinc to enter the water column and become a water quality concern as a secondary source of metals contamination (See section 8.2.3).

4.2.2 TMDL Load Allocations

Load allocations for the impaired water body segments addressed by this TMDL are as follows:

Big River (WBID: 2074) – Because no permitted facilities exist within the Big River watershed that will contribute to the dissolved lead impairment, the wasteload allocation portion of the TMDL is zero. The entire load capacity for dissolved lead will therefore be allocated as a load allocation.

Table 11. Dissolved Lead Load Allocations for Big River (WBID: 2074)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	122	1.5	0	1.5
90%	147	1.8	0	1.8
70%	246	3	0	3
50%	433	5.3	0	5.3
30%	751	9.2	0	9.2
10%	1956	23.9	0	23.9
5%	3297	40.3	0	40.3

Big River (WBID: 2080) – The St. Francois County Environmental Corporation facility is a contributor of lead to Big River and has a wasteload allocation of 1.11 kg/day (Section 4.1.3). The amount of TMDL loading capacity remaining for dissolved lead after wasteload allocations to point sources have been considered will be allocated to nonpoint sources as a load allocation.

Table 12. Dissolved Lead Load Allocations for Big River (WBID: 2080)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	91	1.11	1.11	0
90%	106	1.3	1.11	0.19
70%	178	2.18	1.11	1.07
50%	305	3.74	1.11	2.63
30%	552	6.76	1.11	5.65
10%	1350	16.54	1.11	15.43
5%	2310	28.3	1.11	27.2

The St. Francois County Environmental Corporation and Vessel Mineral Products facilities are contributors of Total Suspended Solids (TSS) to Big River. The combined TSS wasteload allocation for these discharges during low-flow conditions is 1,115 kg/day (Section 4.1.3). The amount of TMDL loading capacity remaining for TSS after wasteload allocations to point sources have been considered will be allocated to nonpoint sources as a load allocation.

Table 13. Total Suspended Solids Load Allocations for Big River (WBID: 2080)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	91	1115	1115	0
90%	106	1299	1115	184
70%	178	2181	1115	1066
50%	305	3736	1115	2621
30%	552	6757	1115	5642
10%	1350	16538	1115	15423
5%	2310	28298	1115	27183

Flat River Creek (WBID: 2168) – Because no permitted facilities exist within the Flat River Creek watershed that will contribute to the dissolved zinc impairment, the wasteload allocation portion of the TMDL is zero. The entire load capacity for dissolved zinc will therefore be allocated as a load allocation.

Table 14. Dissolved Zinc Load Allocations for Flat River Creek (WBID: 2168)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	2.13	1.01	0	1.01
90%	2.8	1.32	0	1.32
70%	6.44	3.05	0	3.05
50%	15.4	7.28	0	7.28
30%	33.6	15.89	0	15.89
10%	100.24	47.4	0	47.4
5%	179.2	84.7	0	84.7

Because no permitted facilities exist within the Flat River Creek watershed that will contribute to the dissolved lead impairment, the wasteload allocation portion of the TMDL is zero. The entire load capacity for dissolved lead will therefore be allocated as a load allocation.

Table 15. Dissolved Lead Load Allocations for Flat River Creek (WBID: 2168)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	2.13	0.026	0	0.026
90%	2.8	0.034	0	0.034
70%	6.44	0.079	0	0.079
50%	15.4	0.189	0	0.189
30%	33.6	0.412	0	0.412
10%	100.24	1.228	0	1.228
5%	179.2	2.195	0	2.195

The Flat River Glass Operations facility is a contributor of TSS to Flat River Creek. Because no calculated reduction in daily load is necessary for this facility, the wasteload allocation portion of the TMDL is equal to the existing effluent limitations for TSS (Section 4.1.3). The amount of TMDL loading capacity remaining for TSS after wasteload allocations to point sources have been considered will be allocated as a load allocation.

Table 16. Total Suspended Solids Load Allocations for Flat River Creek (WBID: 2168)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	2.13	26.1	26.0	0.1
90%	2.8	34.3	26.0	8.3
70%	6.44	78.89	26.0	52.89
50%	15.4	188.65	26.0	162.65
30%	33.6	411.6	26.0	385.6
10%	100.24	1227.9	26.0	1201.9
5%	179.2	2195.2	26.0	2169.2

Shaw Branch (WBID: 2170) – The MDNR, St. Joe State Park facility is a contributor of lead to Shaw Branch and has wasteload allocations as described in Section 4.1.3. Because the MDNR, St. Joe State Park facility encompasses the entire Shaw Branch watershed, all precipitation induced stormwater runoff is generated by and from the facility. Therefore, the entire loading capacity for lead can be allocated to the MDNR, St. Joe State Park facility as wasteload allocations under all flow conditions.

Table 17. Dissolved Lead Load Allocations for Shaw Branch (WBID: 2170)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	0.23	0.003	0.003	0
90%	0.31	0.004	0.004	0
70%	0.71	0.009	0.009	0
50%	1.69	0.02	0.02	0
30%	3.7	0.05	0.05	0
10%	11.03	0.14	0.14	0
5%	19.71	0.24	0.24	0

The MDNR, St. Joe State Park facility is a contributor of Total Suspended Solids (TSS) to Shaw Branch and has wasteload allocations as described in Section 4.1.3. Because the MDNR, St. Joe State Park facility encompasses the entire Shaw Branch watershed, all precipitation induced stormwater runoff is generated by and from the facility. Therefore, the entire loading capacity for TSS can be allocated to the MDNR, St. Joe State Park facility as wasteload allocations under all flow conditions.

Table 18. Total Suspended Solids Load Allocations for Shaw Branch (WBID: 2170)

Percent of time flow is exceeded	Flow (cfs)	TMDL (kg/d)	WLA (kg/d)	LA (kg/d)
95%	0.23	2.9	2.9	0
90%	0.31	3.8	3.8	0
70%	0.71	8.7	8.7	0
50%	1.69	20.8	20.8	0
30%	3.7	45.3	45.3	0
10%	11.03	135	135	0
5%	19.71	241	241	0

5.0 MARGIN OF SAFETY (MOS)

A Margin of Safety (MOS) is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.

(2) Implicit - Incorporate the MOS as part of the critical conditions for the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

The MOS for these TMDLs is implicit and is based on the conservative assumptions used in developing and applying the TMDL load duration curves. The load duration curves target the

chronic criteria for lead and zinc which is protective of both acute and chronic toxicity in the impaired waters. When establishing wasteload and load allocations, the more protective of the percent reduction required for the water body or the TMDL loading was used to set allocations. This approach ensures that water quality standards are achieved under all flow regimes.

6.0 SEASONAL VARIATION

The TMDL curve represents flow under all possible stream conditions. The advantage of a load duration curve approach is that it avoids the constraints associated with using a single-flow critical condition during the development of the TMDL. Because the TMDL is applicable under all flow conditions, it is also applicable for all seasons. Seasonal variation is therefore implicitly taken into account within the TMDL calculations.

While there is significant seasonal variation in the amplitude of the average flow and concentrations of the parameters of concern (Table 19), such variation would not require special consideration in this TMDL because implementation to reduce loading would be applicable all year round.

Table 19: Monthly Average of Selected Parameters During 1962-2006 Period

Month	Average Flow (ft^3/s)	Average Hardness (mg/L)	Average TSS (mg/L)	Average DPb (µg/L)	Average DZn (µg/L)
1	331	256.86	8.23	10.29	644.65
2	199	286.91	5.47	11.39	1105.94
3	323	246.17	46.82	31.82	648.26
4	667	264.29	7.04	8.29	597.01
5	232	357.59	10.23	11.59	749.36
6	102	317.75	12.71	28.45	761.38
7	46	338.36	9.95	29.04	770.50
8	64	231.11	10.69	26.60	1305.60
9	92	376.78	12.48	11.71	322.28
10	45	321.59	4.52	30.33	656.41
11	210	289.40	7.34	12.79	1247.43
12	746	276.88	32.50	17.20	1963.70

7.0 MONITORING PLAN

Currently, the USGS conducts water quality monitoring on Big River near Richwood (USGS 07018000). In addition to collecting daily average discharge, the monitoring schedule includes twice a year sampling for metals and six times a year sampling for water chemistry. The monitoring frequency and analytes collected by the USGS are sufficient to characterize water quality in Big River and should be continued. In addition to monitoring conducted by USGS, the Missouri Department of Natural Resources will continue monitoring the impaired waters covered by this TMDL for pollutants of concern. Additional monitoring of sediments and pore water may be conducted to determine the efficacy of sediment best management practices and to assess water

quality trends against probable effects levels, general criteria [10 CSR 20-7.031(3)], and water quality criteria for lead and zinc.

Facilities that have been determined to cause or contribute to sediment and/or metals loading to impaired segments will be required to measure in-stream pollutant concentrations to determine the efficacy of their control measures. Facilities covered by ARARs must monitor and report analytical results for all pollutants of concern identified in the ARAR document. Entities covered by MS4 permits shall monitor and report the loading of pollutants of concern from their discharges.

8.0 IMPLEMENTATION PLANS

Past metals mining in the Big River Watershed left many tailings, chat piles and slurries. When it rains, the water suspends the fine particles of metal and sediment and carries them to the waterways in the watershed. These particles impair aquatic life through metals toxicity and/or through loss of habitat due to excessive sedimentation. Several federal, state, and local government agencies are working diligently to remediate old mine sites and promote best management practices in the watershed. The following implementation strategies will be employed to supplement these efforts and ensure improvement of water quality within the watersheds addressed by this TMDL.

8.1 Point Sources

This part of the TMDL will be implemented through permit action. Effluent limits and monitoring requirements for the parameters of interest will be re-evaluated to reflect the water quality targets set by the TMDL as the affected permits come up for renewal. All permitted facilities that are identified to contribute sediment and metals loading to impaired segments shall adopt appropriate Best Management Practices (BMPs) to reduce such loading from their storm water outfalls. These facilities must also regularly measure in-stream pollutant concentrations to determine the efficacy of the control measures.

General and storm water permits which apply to areas containing NVSS, lead and zinc sources within the Big River watershed shall be inspected during the implementation phase of this TMDL to determine facility compliance with the terms of the general permit. During the facility inspection, recommendations will be given for implementing and maintaining best management practices that are protective of the impaired streams from future pollutant loading. Should a facility be determined to cause or contribute to an impairment, a site-specific permit can be issued to the facility that contains WLAs for NVSS, lead, and/or zinc that are protective of water quality. Provisions are contained in each general permit that allow the department to revoke the general permit and issue a site-specific permit in its place should more protective permit conditions be required to correct an impairment caused by the facility.

MS4 permits within the Big River watershed shall include requirements sufficient to characterize the loading of pollutants of concern from these discharges. Systems that are determined to contribute pollutants of concern to impaired water body segments shall include requirements and conditions in the MS4 permit sufficient to characterize and reduce the impacts from these discharges.

8.2 Nonpoint Sources (NPS)

To address nonpoint sources of pollution, this TMDL will be implemented through two main approaches. First, by preventing more contaminated sediment from entering the Big River system through stabilization of six tailings piles (listed below). Second, by removing sediment and associated metals contamination from the river.

8.2.1 Stabilizing Tailings Piles

The Big River Mine Tailings/St. Joe Minerals Corporation site was placed on the U. S. Environmental Protection Agency's (EPA) Superfund National Priorities List (NPL) in October 1992. Superfund non-time-critical[11] removal actions are in various stages of planning and construction at the six large chat piles within the site area to stabilize the tailings against wind and water erosion and mass movement. Time-critical removal actions[12] have been ongoing for several years to replace yard soils in the area contaminated by mine-related wastes and processes. Investigations are underway to characterize off-site and downstream contamination that may pose risks to people and ecological receptors. Below is an update of the six sites and the status of other ongoing actions.

Desloge [Big River] Mine Tailings Site: Non-time-critical removal action construction to stabilize the tailings against wind and water erosion and mass movement was completed in autumn of 2000. Efforts to cover the tailings with vegetation continue. Biosolids application is being used to assist the revegetation. This site contains the soil repository[13] for time-critical yard soil removal actions conducted in the area.

Bonne Terre Mine Tailings Site: Non-time-critical removal action construction to stabilize the tailings was completed in late 2003 for the western portion of the site, including the tailings pile and intermediate areas. It is anticipated that the eastern portion of the site will be completed by 2007. There are still a few small areas needing soil and vegetation cover and the service roads need to be covered with rock.

Elvins/Rivermines Mine Tailings Site: Non-time-critical removal action construction to stabilize the site was completed in autumn 2006 and the work crew demobilized from the site.

Leadwood Mine Tailings Site: The potentially responsible party (PRP), under an Administrative Order on Consent, completed the Engineering Evaluation/Cost Analysis (EE/CA). The EPA has finalized the Removal Action Memorandum. The EPA issued a Unilateral Administrative Order (UAO) to the PRP in September 2006 for design and construction of the non-time-critical removal action. Non-time-critical removal action construction started in early autumn 2006.

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[11] In instances where hazardous substance releases need at least six months of planning time for the removal action, the EPA or the potentially responsible parties may conduct a non-time-critical removal action.

[12] If hazardous substance releases pose an immediate threat to human health or the environment for which there is limited planning and response time, time-critical removal actions may be conducted.

[13] A soil repository is an approved location for storing lead contaminated yard soils, which are removed from residential yards. The approved location must be an already contaminated site.

National Mine Tailings Site: The EPA and a contractor completed the EE/CA, and the EPA finalized the Removal Action Memorandum. The EPA issued a UAO to the PRPs for design and construction of the non-time-critical removal action. The PRPs have begun the removal action design process.

Federal Mine Tailings Site: Human health and ecological risk assessments have been completed, and the EPA has granted the PRPs an extension until February 2007 for submittal of a draft EE/CA. This tailings site is located in St. Joe State Park and Missouri Mines State Historic Site.

8.2.2 Status of Other Superfund Actions

There are also interim time-critical removal actions that have taken place. Under Administrative Orders on Consent between the EPA and the PRP, the PRP has conducted replacement of residential soils contaminated by mine-related processes for several years. Over 400 yards have been cleaned up through these actions. This will progress at a rate of 60 yards per year until a Record of Decision is completed, which will continue residential soil cleanups through the remedial process.

Area-wide Remedial Investigation and Feasibility Studies (RI/FS) for the residential yard remedial action are in progress. The EPA and PRPs have conducted sampling and analyses for completion of the RI/FS for off-site and downstream impacts as a result of releases from the mine-related sites, and EPA has completed the baseline ecological risk assessment. However, additional sampling and analyses are needed to complete sediment studies. Additional off-site sampling and analyses (railroad beds, etc.) also need to be completed.

8.2.3 Sediment Removal

After the tailings piles are stabilized, so that no more sediment will enter Big River, removal of contaminated sediment from the waterways must be considered. A large amount of this sediment is already in the Big River, due in part to sediment continuously entering the river via erosion from all six piles. Additionally, part of the Desloge tailings pile, which is situated within a large loop of Big River, washed into the river in 1977, creating huge gullies. The largest gully was approximately 200 feet across and about 80 feet deep (Novak and Hasselwander 1980). The incident deposited volumes of tailings in the river, possibly as much as 50,000 cubic yards. Through the years, these tailings have gradually moved downstream, contaminating more and more of the river as they have spread. According to a sediment study that the department's Environmental Services Program conducted in 2002and 2003, this contaminated sediment has traveled downstream and significantly impaired Big River at least as far as St. Francois State Park. Various options for removing fine sediment from Big River and Flat River Creek are being studied. A major concern is how to remove sediment without additional harm occurring to the river environment. Both active and passive removal options are under consideration.

8.2.4 Other Remedial Activities

In addition to the Superfund actions, there are two active grant projects in St. Francois County. A Clean Water Act Section 319 grant for $438,608 was awarded in 2004 and an Agricultural Nonpoint Source Special Area Land Treatment (AgNPS SALT) grant was awarded in 2005 for $246,500. These grants are being administered through the St. Francois County Soil and Water Conservation District (SWCD) and last for five years and seven years, respectively. They include

such goals as plugging the dry drill holes (from mining exploration), utilizing the flowing drill holes as cattle watering sources, restoring pastures and riparian buffers, fixing gully erosion and protecting woodlands. Also, a watershed management plan is required under the 319 grant. These measures will help protect the surface and ground water quality in Big River and prevent more sediment from entering the system. See Appendix C for a map of the areas covered by the grants.

The department held several meetings in the spring and summer of 2007 in St. Francois County to facilitate the formation of a citizen-led environmental group for the Big River Watershed. The purpose of this group is to engage the public in helping to remediate damage to the Big River and its watershed from mining waste, as well as to address any other environmental issues the group chooses. The group is broad based and open to anyone who lives or works in the watershed, uses the river (swimming, fishing, etc.) or otherwise has an interest in its health. This includes country landowners, town residents, businesses, SWCDs, Missouri Stream Teams, county and municipal governments, and many more. The group is starting to run on its own and has elected interim officers. Several projects and activities are already taking shape. Some of the things this citizen's group can do include:

- Review and comment on documents and proposals by EPA/Doe Run related to tailings pile stabilization.
- Check on remediated piles to ensure stability and to reduce vandalism.
- Educate the public about health protection measures related to blood lead levels, especially in children under six years old.
- Educate public on where and how to get their blood lead levels tested.
- Review and comment on contaminated soil (yards) removal proposals.
- Gather ideas on contaminated sediment removal alternatives for future action.
- Act as a watchdog group (eyes and ears for reporting infractions) regarding illegal dumping of trash (including tires), removal and spreading of lead tailings/contaminated sediment and improper sand and gravel "mining".

9.0 REASONABLE ASSURANCES

The department has the authority to write and enforce State Operating Permits. Inclusion of effluent limits (determined from the waste load allocations established by the modeling) into a state permit, and at least quarterly monitoring of the effluent reported to the department, will result in compliance with water quality standards being met. In most cases, "Reasonable Assurance" in reference to TMDLs relates only to point sources. As a result, any assurances that NPS contributors of sediment, lead and zinc will implement measures to reduce their contribution in the future, will not be found in this section. Instead, discussion of reduction efforts relating to NPS can be found in the "Implementation" section of this TMDL.

10.0 PUBLIC PARTICIPATION

These water quality limited segments are included on the approved 2002 303(d) List for Missouri. The department's Water Protection Program developed this TMDL. This document was first placed

on a 30-day public notice from Dec. 20, 2006 through Jan. 19, 2007. Comments were received from EPA and Missouri Coalition for the Environment. In response to these comments, the department made several changes to the document. For this reason, it was placed on another 30-day notice. This public notice period was from Sept. 24, 2007 to Oct. 24, 2007. Groups that received the public notice announcement included the Missouri Clean Water Commission, the four facilities with site specific permits, the Water Quality Coordinating Committee, the new citizen's Big River watershed group, 137 Stream Team volunteers in the watershed and the 11 state legislators representing the Big River Watershed. Also, the notice, the Information Sheets and this document were posted on the department Web site, making them available to anyone with access to the Web. Any comments received and the department's response to those comments have been placed in the Big River file.

11.0 APPENDICES AND LIST OF DOCUMENTS ON FILE WITH THE DEPARTMENT

11.1 Appendices (page numbers)

11.2 Administrative Record and Supporting Documentation

An administrative record on the Big River, Flat River Creek and Shaw Branch TMDLs has been assembled and is kept on file with the Missouri Department of Natural Resources. It includes the list below (ordered by date of study). In addition, there are numerous other studies and papers on the Big River and its tributaries citing the negative effects of mining and its aftereffects on that river system. These studies date from the 1950s and many of them reside in the department's files.

A Summary of the 1998 [and 1999] Metals Analysis for Big River and Flat Creek, University of Missouri-Rolla, for Doe Run Co., Viburnum, MO [two documents]

Biological Assessment and Sediment Study, Flat River (Flat River Creek), St. Francois County, 2001, DNR Environmental Services Program

Biological Assessment and Fine Sediment Study for Upper Big River, Washington County, 2001-2002, DNR Environmental Services Program

Lead, zinc, copper and cadmium in fish and sediments from the Big River and Flat River Creek of Missouri's Old Lead Belt, 2002, Nord L. Gale et al.

Biological Assessment and Fine Sediment Study for Big River (lower), Irondale to Washington State Park, 2002-2003, DNR Environmental Services Program

Biological Assessment and Fine Sediment Study for Eaton Branch [drains the Leadville pile], St. Francois County, 2003-2004, DNR Environmental Services Program

Modeling calculations and statistics for the Big River system

Big River and Flat River Creek TMDL Information Sheet
Shaw Branch TMDL Information Sheet
Comments received from EPA and Missouri Coalition for the Environment during the first public comment period (12/20/06 – 1/19/07) and Doe Run during the second (9/24-10/24/07) and the department's responses.

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Appendix A – Land Use Maps

Figure A: Land Use Type and Distribution in the Big River Watershed

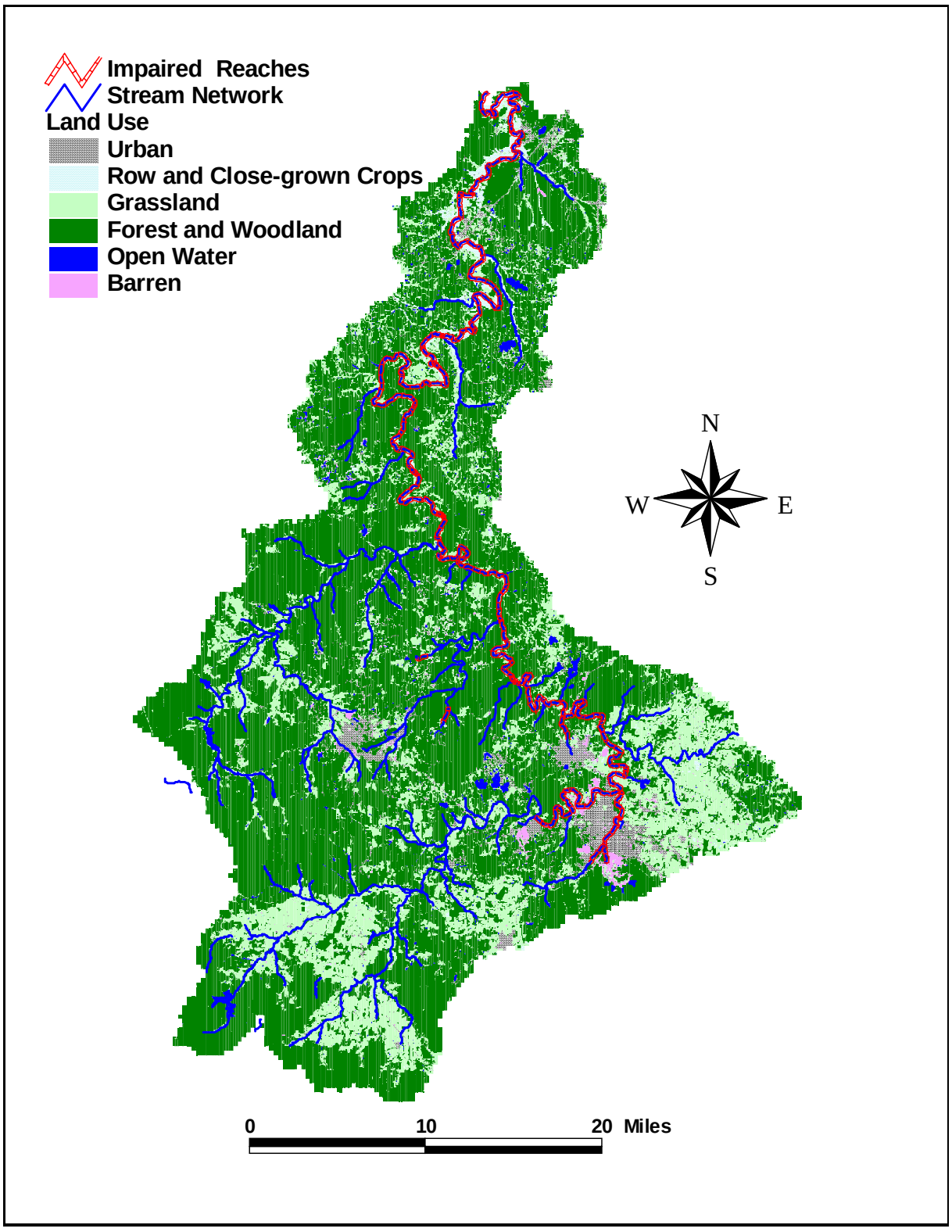
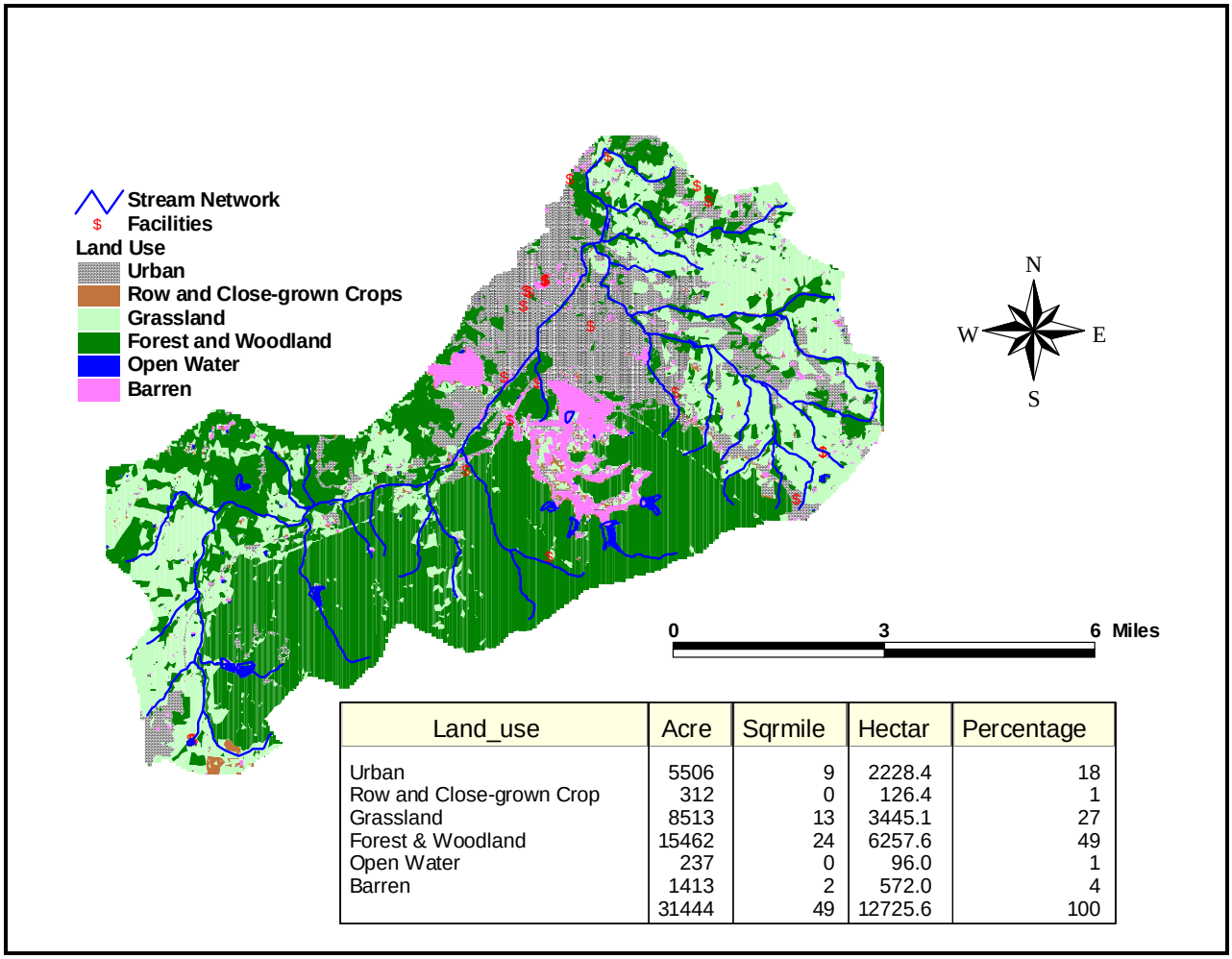


Table A-1: Land Use Type and Distribution in Big River Watershed (see Figure A).

Land Use	Acres	Square miles	Hectare	Percentage
Urban	25,809	40.33	10,445	4.1
Row and Close-grown Crops	12,974	20.27	5,251	2.1
Grassland	144,564	225.88	58,505	23.2
Forest & Woodland	423,273	661.36	171,298	67.9
Open Water	11,713	18.30	4,740	1.9
Barren	4,916	7.68	1,989	0.8
Total	**623,249**	**973.83**	**252,229**	**100**

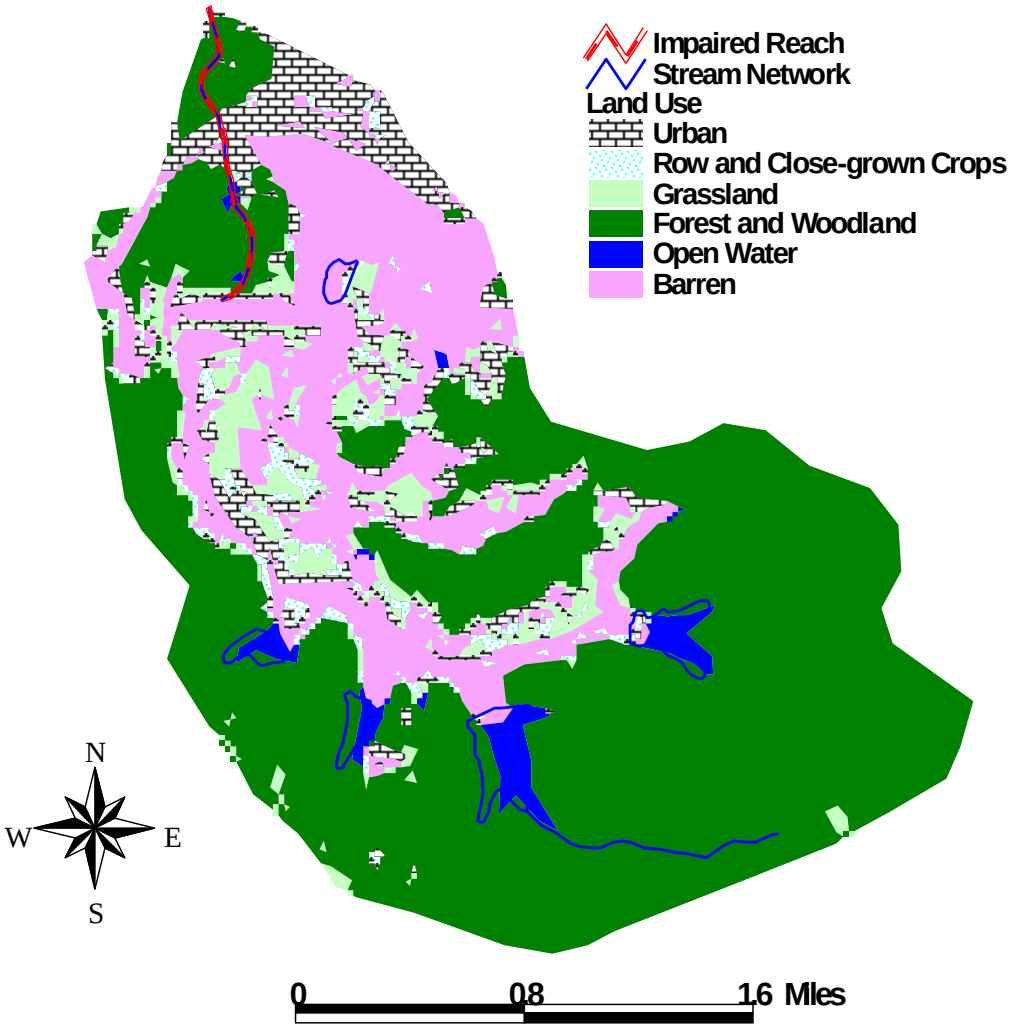
Figure B: Land Use type & Distribution in the Flat River Creek Watershed



Land_use	Acre	Sqrmile	Hectar	Percentage
Urban	5506	9	2228.4	18
Row and Close-grown Crop	312	0	126.4	1
Grassland	8513	13	3445.1	27
Forest & Woodland	15462	24	6257.6	49
Open Water	237	0	96.0	1
Barren	1413	2	572.0	4
	31444	49	12725.6	100

Data from 2000 (30-meter resolution), obtained from Thematic Mapper imagery, was used to calculate the land use statistics for these land use maps.

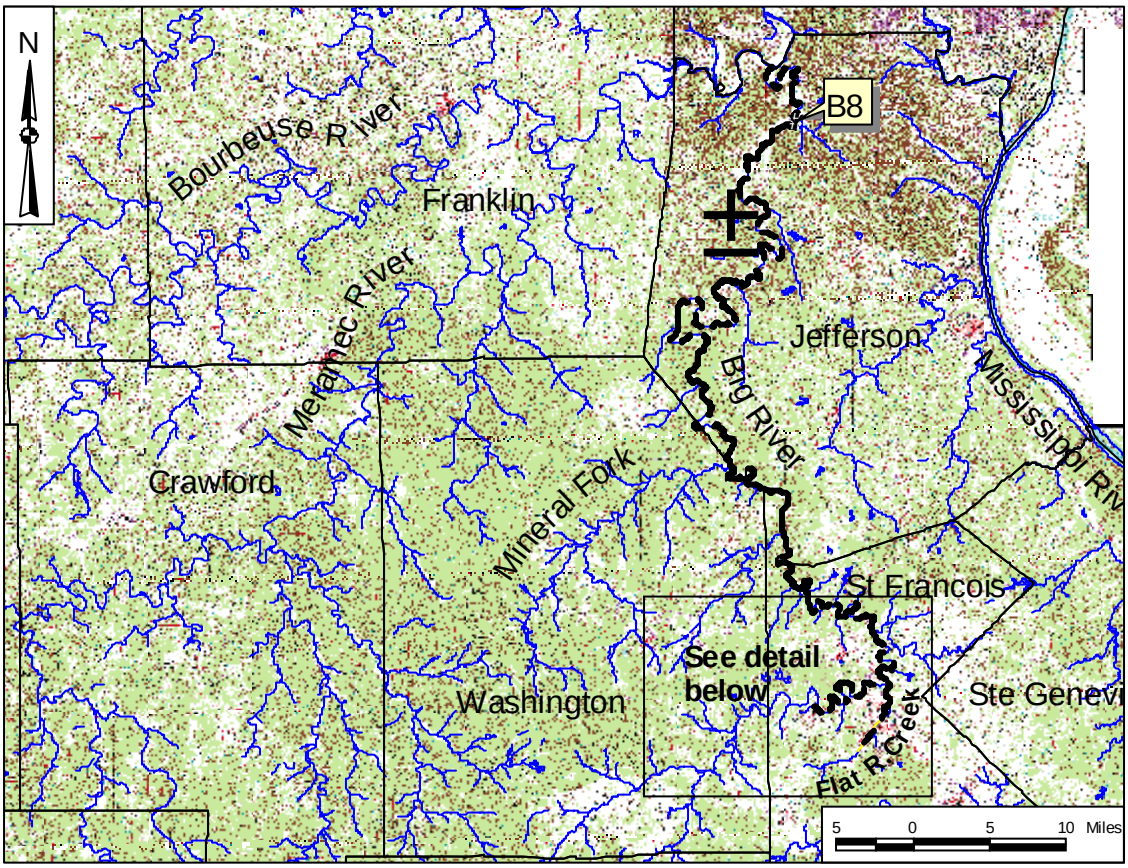
Figure C: Land Use Type and Distribution in the Shaw Branch Watershed



Land_use	Acres	Sqrmiles	Hectare	Percentage
Urban	306	0.478	123.8	8.5
Row and Close-grown Crop	90	0.140	36.4	2.5
Grassland	219	0.342	88.6	6.1
Forest & Woodland	2165	3.382	876.1	60.5
Open Water	74	0.115	29.9	2.1
Barren	727	1.135	294.2	20.3
	3580	5.59	1449	100.0

Appendix B
Topographic Maps with Sampling Sites

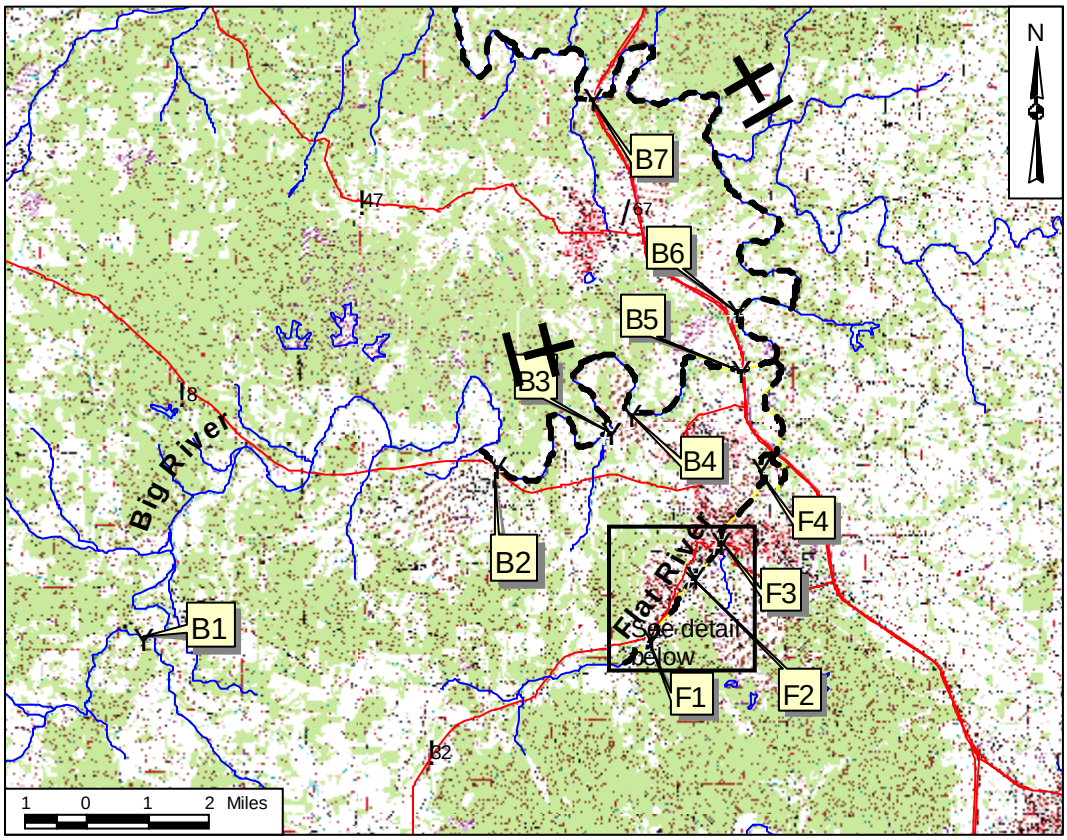
B.1. Impaired Segments of Flat River Creek and Big River in St. Francois and Jefferson Counties, Missouri, and Sampling Site



Impaired segment → Direction of flow

Sample Site
B8 – Big River at House Springs Access

B.2. Detail of Sampling Sites for Big River and Flat River Creek

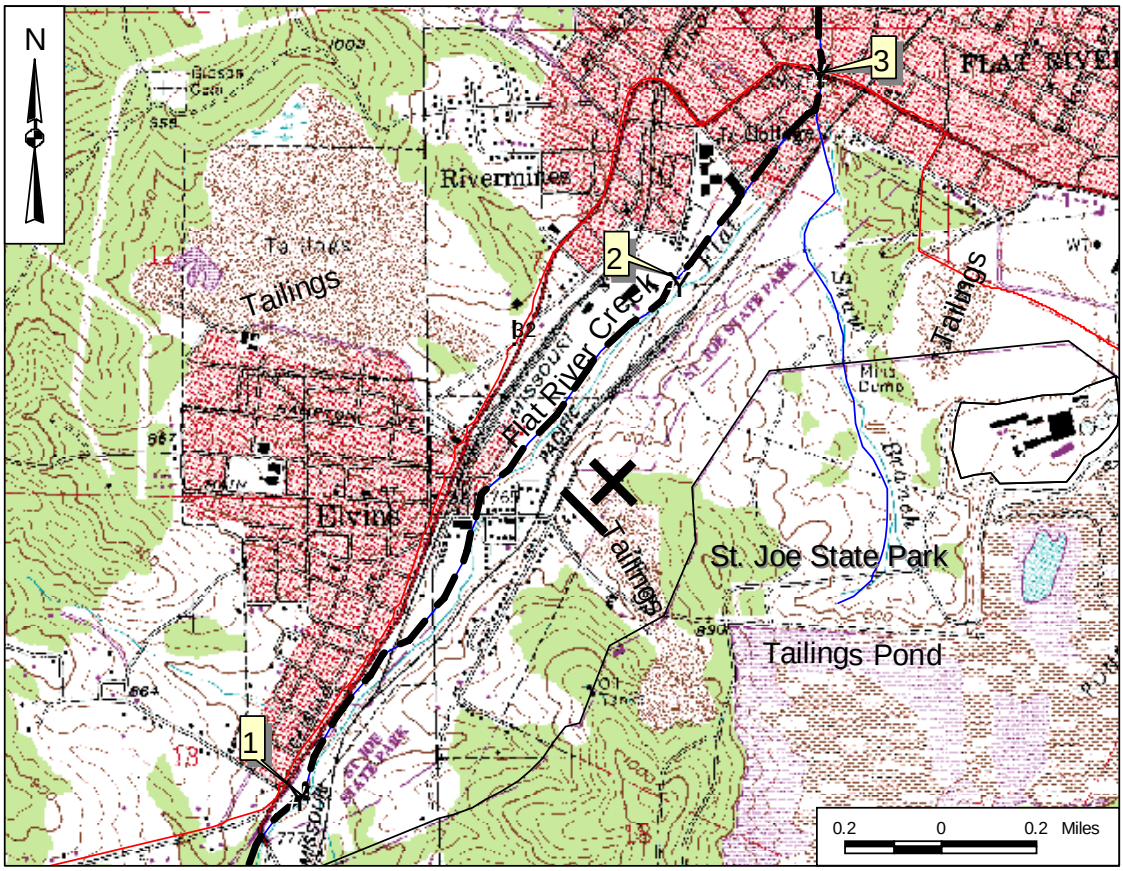


Sample Site Index

B1 – Big River at Irondale
B2 – Big River at Leadwood access
B3 – Big River at Bone Hole
B4 – Big River at East end of Desloge tailing pile
B5 – Big River below Desloge
B6 – Big River 1.2 miles below Flat River Creek
B7 – Big River 11.7 miles below Flat River Creek

F1 – Flat River Creek at Derby
F2 – Flat River Creek just below Elvins tailing pile tributary
F3 – Flat River Creek at Main Street, town of Flat River
F4 – Flat River Creek below National chat pile

B.3. Detail of Flat River Creek

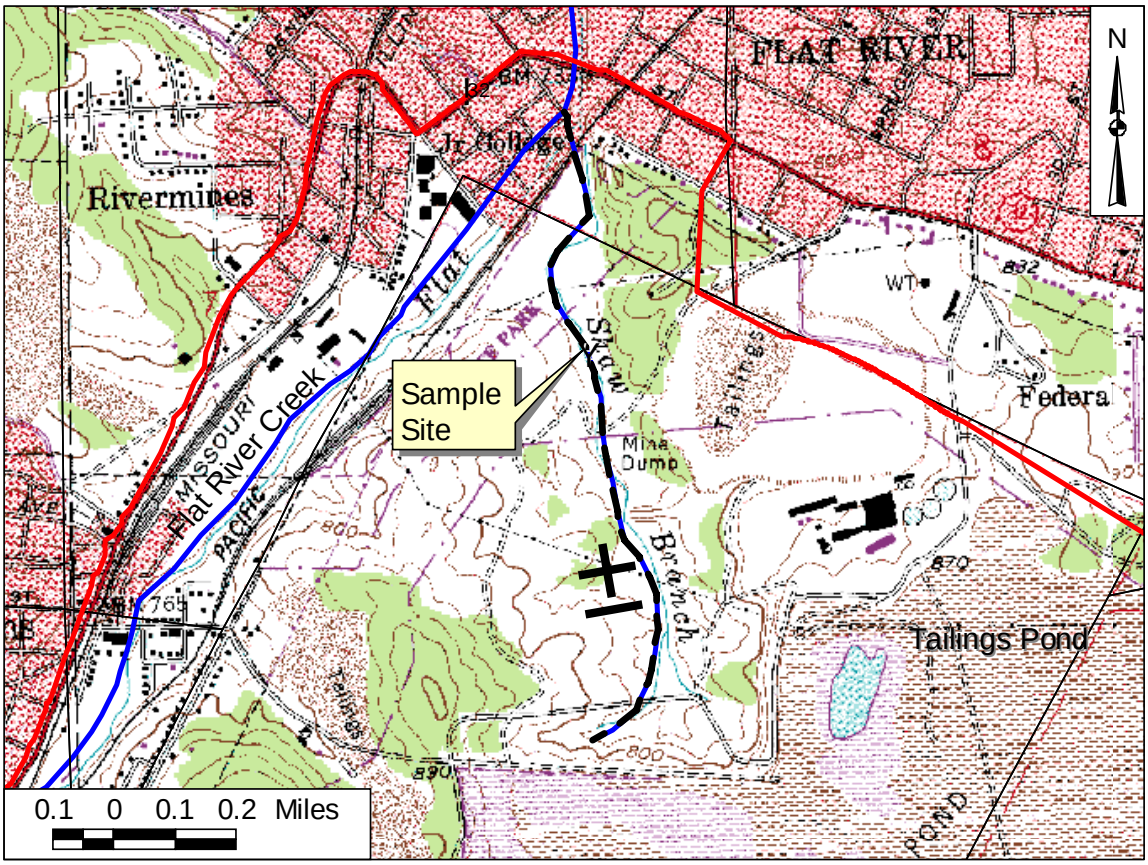


Impaired Segment → Direction of flow

Site Index

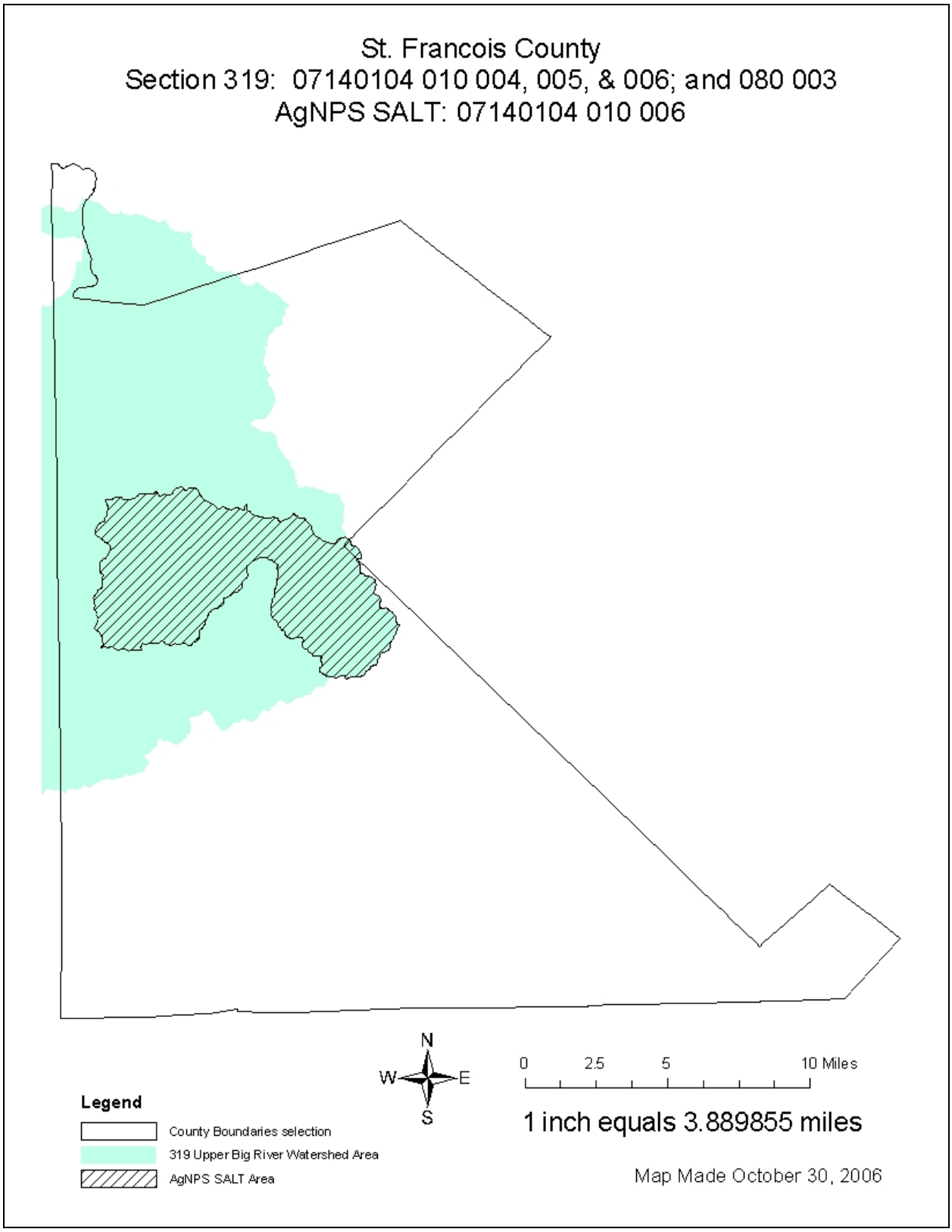
1 – Flat River Creek at Hwy B
2 – Flat River Creek at Rivermines
3 – Flat River Creek at Main Street, Flat

Impaired Segment of Shaw Branch in St. Francois County, Missouri, with Sampling Site



Impaired Segment → Direction of flow

Appendix C – Map of area covered in the Ag NPS SALT and 319 grants



Appendix D - Current facilities in the Big River Basin

Watershed	Permit #	Facility Name	Design Flow (MGD)
2170	MO0097993	MDNR, ST JOE STATE PARK	8.64
2168	MO0022942	BISMARCK WWTF	0.25
2168	MO0053180	TOWN AND COUNTRY MHP	0.015
2168	MO0092134	RUSTIC ACRES	0.007
2168	MO0092941	SUGAR MAPLE COURT MOBILE	0.008325
2168	MO0097993	MDNR, ST JOE STATE PARK	0.01
2168	MO0098647	FLAT RIVER GLASS OPERATIO	1.2
2168	MO0103560	PARK HILL WWTF	2.05
2168	MO0123633	NEW HOPE RESIDENTIAL	0.002
2168	MOG640065	PARK HILLS WTP	
2168	MOG821108	W M PUMPING	
2168	MOR040004	FARMINGTON SMALL MS4	
2168	MOR23A113	NPC BIDCO	
2080	MO0001422	VESSELL MINERAL PRODUCTS	0.5
2080	MO0035700	TERRE DU LAC NORTH	0.24
2080	MO0049000	BISMARCK W STORMW	VARIES
2080	MO0057312	TERRE DU LAC SOUTH LAGOON	0.004
2080	MO0058378	COUNTRY HILL MHC	0.011
2080	MO0083810	SHIRLEY SCHOOL	0.00043
2080	MO0084395	GRANDVIEW PLAZA MHP	0.007
2080	MO0085111	BELLEVIEW R-3 SCHOOL	0.004
2080	MO0086240	BELGRADE R-6 ELEM SCH	0.003
2080	MO0087025	POTOSI ELKS CLUB #2218	0.001
2080	MO0087181	ROUGE CREEK UTILITIES, IN	0.03
2080	MO0087921	KINGSTON K-14 SCHOOL	0.005652
2080	MO0089745	SERENITY MHP	0.002
2080	MO0089893	WHISPERING PINES MHP	0.001
2080	MO0090522	SUMMIT ACRES MHP	0.007
2080	MO0090913	LAKE KINIPPI SUBDIVISION	0.005
2080	MO0094242	BELLEVIEW VALLEY NURSING	0.014
2080	MO0095311	TERRE DU LAC OXIDATION DI	0.25
2080	MO0099431	POTOSI WWTP #1	0.683
2080	MO0099732	POTOSI WWTF #2	0.21
2080	MO0100706	BONNE TERRE NW WWTF	0.61
2080	MO0101184	BUCKMAN LABORATORIES INC	
2080	MO0104256	LEADWOOD WWTF	0.15
2080	MO0108774	ST FRANCOIS CO ENVIR CORP	1.2
2080	MO0109568	IRONDALE WWTF	0.06
2080	MO0110035	THUNDERBIRD MHP	0.004
2080	MO0120260	EAGLE ESTATES	0.031
2080	MO0121321	BONNE TERRE NE WWTP	0.9

Watershed	Permit #	Facility Name	Design Flow (MGD)
2080	MO0121371	HUNTER'S RIDGE SUBDIVISIO	0.025
2080	MO0123544	BATES CREEK BAPTIST CAMP	0.00806
2080	MO0123765	VILLAGE TRAILER COURT	0.003
2080	MO0125083	WEST ST. FRANCOIS CO R-IV	0.012
2080	MO0127388	MOORE RECIRCULATING FILTR	0.000975
2080	MO0127922	YMCA OF THE OZARKS	0.01915
2080	MO0128571	CALEDONIA WWTF	0.02
2080	MOG010259	DAVID, KEN	
2080	MOG010372	DAVID, JOHN W	0.069825
2080	MOG490214	LEAD BELT MATERIALS - QUA	VARIES
2080	MOG490230	BIG RIVER MINE TAILINGS	VARIES
2080	MOG490356	POLITTE READY MIX	
2080	MOG490439	POLITTE READY MIX	
2080	MOG490736	EGYPTIAN CONCRETE COMPANY	
2080	MOG490805	BASE ROCK MINERALS INC.	
2080	MOG490807	WASHINGTON CO. AGGREGATES	
2080	MOG490947	CIMBAR PERFORMANCE MINERA	
2080	MOG500110	WA CO MATERIALS	
2080	MOG821031	HAWK'S BACKHOE SERV,INC	
2080	MOG821067	JONES PLUMBING SERVICE	
2080	MOG821072	RIDDLE SEPTIC CLEANING	
2080	MOG821108	W M PUMPING	
2080	MOG821117	WM PUMPING	
2080	MOR22A137	REED LUMBER COMPANY, LLC	
2080	MOR23A062	ORICA USA	
2080	MOR240061	R & M FEED	
2080	MOR240227	DICKEY FARM SUPPLY INC	
2080	MOR80C018	BSC TRUCK INC	
2080	MOR80H010	GILLIAM TRANSFER SOLID WA	
2074	MO0040461	MO AMERICAN, CEDAR HILL L	0.164
2074	MO0043818	GRANDVIEW R-2 SCHOOL DIST	0.013
2074	MO0044571	COUNTRY AIRE MANOR MHP	0.022
2074	MO0044580	HSSC, NORTHWEST HIGH SCH	0.075
2074	MO0045446	LAKES OF DEERWOOD SUBD	0.005
2074	MO0049441	STARLIGHT APTS.	0.001
2074	MO0053163	OUR LADY QUEEN OF PEACE	0.005
2074	MO0053708	LAKE ADELLE SEWER DIST	0.05
2074	MO0084450	CREST MANOR MHP	0.048
2074	MO0085383	HILLSBORO WW RECLAMATION	0.5
2074	MO0086363	SYCAMORE GREEN ACRES MHP	0.005
2074	MO0086576	BEL AIR ESTATES MHP	0.012
2074	MO0086932	FISHER COMMERCIAL AREA	0.001
2074	MO0088951	TRANSFORMATION CAMP	0.002

Watershed	Permit #	Facility Name	Design Flow (MGD)
2074	MO0089354	LAKE TAMARAC SUBD	0.027
2074	MO0090051	PARADISE ESTATES MHP WWTF	0.003
2074	MO0090395	EL CHAPARREL EST SUBD ASO	0.017
2074	MO0090905	COUNTRY LIFE ACRES SUBD	0.003
2074	MO0090948	GREEN ACRES MHP	0.009
2074	MO0092584	GOLDEN ACRES MHP	0.024
2074	MO0092738	MAPLE GROVE ELEM SCHOOL	0.01
2074	MO0098302	CEDAR HILL FPD	0.001
2074	MO0099091	ELDERLY HOUSING PRTNRSHP	0.008
2074	MO0099473	RAINTREE PLANTATION	0.064
2074	MO0099635	JEFFERSON CO PWSD #2	0.092
2074	MO0099635	JEFFERSON CO PWSD #2	0.05
2074	MO0100374	HSSC, HOUSE SPGS MID SCH	0.016
2074	MO0100668	HSSC, ECHO VALLEY EST	0.018
2074	MO0101893	CAMP SUNNYHILL ADVENTURE	0.0108
2074	MO0101958	JEFFERSON COUNTY LIBRARY	0.012
2074	MO0103233	HSSC, BEAR CREEK ESTATES	0.0421
2074	MO0103438	HSSC, WOODRIDGE ESTATES	0.018
2074	MO0103446	COUNTRY TRAIL ESTATES MHP	0.006545
2074	MO0103551	AUSTIN TRAILS	0.002
2074	MO0103799	MO AMERICAN, SAND CREEK F	0.075
2074	MO0105201	HSSC, PINE GROVE MANOR	0.004
2074	MO0105597	SECLUDED FOREST SUBD	0.009
2074	MO0105856	BYRNES MILL MHP	0.125
2074	MO0105970	WEDGEWOOD VILLAGE-PLAT 2	0.023
2074	MO0106577	SENNAWOOD VILLAGE SUBD	0.026
2074	MO0106909	HSSC, MEADOW BROOK ESTATE	0.09
2074	MO0108642	HSSC, SYCAMORE SPGS MHP	0.048
2074	MO0109304	HSSC, CEDAR SPGS ELEM SCH	0.012
2074	MO0110019	PINE FORD VILLAGE MHP	0.03
2074	MO0111457	FEED MY PEOPLE	0.001
2074	MO0113191	SUNRISE ACRES SUBDIVISION	0.002
2074	MO0115223	SEVEN SPRINGS/TWIN LAKES	0.049
2074	MO0115428	BYRNES MILL SOUTH WWTP	0.5
2074	MO0120600	ST MARTIN'S UNITED CHURCH	0.0011
2074	MO0123561	MEADOWBROOK VALLEY ESTATE	0.01
2074	MO0124788	HSSC, MILLER CROSSING WTF	0.025
2074	MO0126926	HSSC, FISHER RD	0.1
2074	MO0127345	WACO LANDFILL	2.3
2074	MO0129097	PHILLIPS PROPERTY WWTF	0.0006
2074	MOG490169	HOUSE SPRINGS QUARRY	
2074	MOG490359	ARNOLD READY MIX-CEDAR HI	
2074	MOG490390	CONCRETE RESOURCES INC -	

Watershed	Permit #	Facility Name	Design Flow (MGD)
2074	MOG490532	AAA ZOELLNER MATERIALS IN	
2074	MOG490998	DRY CREEK MATERIALS INC	
2074	MOG500086	DRY CREEK MATERIALS, INC.	
2074	MOG821017	KING SEPTIC SERVICE	
2074	MOG821026	WALLACH SEPTIC SERV, INC	
2074	MOG821055	IMPERIAL PUMPING	
2074	MOG821074	O'BRIEN EXCAVATING	
2074	MOG821096	RITE NOW SEPTIC CLEANING	
2074	MOG821116	AA QUICK SEWER	
2074	MOG821123	BONACKER FARMS	
2074	MOG821126	DON ROBINSON TRACT	
2074	MOG822125	DITTMER MEAT PACKING COMP	
2074	MOR040052	JEFFERSON CO SMALL MS4	
2074	MOR60A080	BIG 3 AUTO PARTS & SALVAG	
2074	MOR80C333	NORTHWEST R-1 SCHOOL DIST	
2074	MOR80C429	DURHAM SCHOOL SERVICES	

Appendix E – Water quality sampling site location

Watershed	Site	Site Name	Latitude	Longitude
2074	2074/38.1	Big River @ Hwy Y	38.2329	-90.6853027
2074	2074/44.7/1.2	Maupin Cr.@ Hwy WW	38.2419	-90.7565002
2074	2074/48.3	Big River @ Brown's Ford	38.2123	-90.7060013
2074	2074/53.0	Big R. near Richwoods	38.1594	-90.7061
2074	2074/9.2	Big River @ Rockford Beach	38.4208	-90.5887
2074	2077/0.4	Ditch Cr. near mouth	38.2287	-90.7449036
2080	2080/11.6	Big River near Washington St. Pk.	38.0846	-90.6622009
2080	2080/20.4	Big R. upstream of Mill Creek	38.0068	-90.62378
2080	2080/30.2	Big River 11.7 mi. below Flat River Cr.	37.9549	-90.552002
2080	2080/32.4	Big River @ St Francois State Park	37.9595	-90.5403
2080	2080/36.9	Big R. upstream of Bonne Terre	37.9257	-90.49877
2080	2080/40.7	Big River 1.2 mi. below Flat River Cr.	37.9035	-90.5108032
2080	2080/41.9	Big River just bl. Flat River	37.8922	-90.5
2080	2080/42.5	Big River below Desloge	37.8895	-90.5102997
2080	2080/45.4	Big R. just bl. Desloges TP	37.88	-90.5444031
2080	2080/48.58	Seep from tunnel	37.8756	-90.5485992
2080	2080/48.6	Big River @ Bone Hole	37.8756	-90.5494385
2080	2080/48.6/0.1	Mine-a-Joe Cr. bl. landfill	37.875	-90.5484009
2080	2080/48.6/0.5	Mine-a-Joe Cr. ab. LF	37.8729	-90.5449982
2080	2080/48.6/0.5/.0	Southwest Cr. @ Mine-a-Joe Cr.	37.8722	-90.5455017
2080	2080/48.62	Surcharging GW from drill hole	37.8753	-90.5497208
2080	2080/55.6	Big R. 0.7 mi. below Eaton Br.	37.8656	-90.5785
2080	2080/58.8	Big R. 2.5 mi. above Eaton Br.	37.8677	-90.6399002

Watershed	Site	Site Name	Latitude	Longitude
2080	2080/65.5	Big River at Irondale	37.83	-90.6906967
2080	2080/68.3	Big River just bl. Cedar Cr.	37.8118	-90.7205
2080	2080/71.6	Big R. near Belgrade	37.811	-90.773201
2080	2080/73.4	Big R. DS of Clear Cr.	37.7988	-90.79867
2080	2080/8.5	Big R. @Washington State Park	38.0872	-90.68253
2080	2081/5.5	Mineral Fork @Hwy 47	38.0908	-90.748703
2080	2084/1.8	Fourche Renault Cr. ab. Hwy 185	38.0124	-90.877
2080	2111/1.4	Old Mines Cr. @Hwy 47	38.0761	-90.7390976
2080	2118/3.2	Mill Cr. @Tiff, Mo.	38.0155	-90.6508026
2080	2118/8.5	Mill Creek ab. Hwy 47	37.9789	-90.66655
2080	2118/2.9	Mill Creek bl. Tiff	38.0191	-90.64961
2080	2140/0.4	Furnace Cr. 0.4 mi. US of Big R.	37.8169	-90.77672
2080	2141/0.3	Clear Cr. near Mouth	37.7994	-90.8026962
2080	2149/0.7	Big River above Council Bluff Lake	37.7049	-90.9164963
2080	2152/1.7	Cedar Cr. 3 mi. NE of Caledonia	37.7929	-90.7337036
2080	2157/1.7	Saline Cr. 2 mi. SSE of Caledonia	37.7295	-90.7462997
2080	2166/0.2	Eaton Br. @ CR near mouth	37.8714	-90.59191
2080	2166/0.4	Eaton Br. 0.4 mi. below Leadwood TP	37.8703	-90.5951996
2080	2166/0.05	Eaton Branch near mouth	37.8726	-90.58879
2080	2177/0.2	Coonville Creek near Mouth	37.9697	-90.5332
2080	2081/2.5	Mineral Fork above Kingston CA	38.0967	-90.71055
2080	2081/12.5	Mineral Fork below Hwy F	38.0527	-90.82036
2080	3282/1.2/0.3	Bonne Terre WWTP outfall 001	37.9378	-90.54794
2080	3282/1.2/0.1	Trib from Bonne Terre WWTP near mouth	37.9384	-90.5524
2080	3282/0.6/0.1	Trib. To Turkey Cr. near mouth	37.9472	-90.55947
2080	3282/1.1/0.1	Trib2. To Turkey Cr. near mouth	37.943	-90.55475
2080	3282/2.2	Turkey Cr. @Hwy 47, ab. Chat pile	37.9231	-90.54847
2080	3282/1.0	Turkey Cr. 0.5 mi. bl. Bonne Terre WWTP	37.9419	-90.55431
2080	3282/1.4	Turkey Cr. bl. Chat pile & ab. WWTP trib.	37.9366	-90.55272
2080	3282/0.3	Turkey Cr. DS of tailings & DS of WWTP	37.951	-90.55848
2080	3282/1.8	Turkey Cr. near Bonne Terre chat pile	37.9308	-90.55295
2080	3282/0.1	Turkey Cr. near mouth	37.954	-90.5572
2168	2168/3.6	Flat River @ Flat River	37.8525	-90.5162
2168	2168/6.0	Flat River Cr. @ Derby, MO.	37.8266	-90.539299
2168	2168/8.8	Flat River Cr. 0.4 mi. ab. Dry Cr.	37.8154	-90.5884018
2168	2168/7.6	Flat River Cr. 0.6 mi. below Dry Cr.	37.818	-90.5700989
2168	2168/3.1	Flat River Cr. just ab. National TP	37.8569	-90.5098038
2168	2168/4.6	Flat River Cr. just ab. Elvins TP trib.	37.8391	-90.5277023
2168	2168/6.3	Flat River Cr. just bl. Banister Br.	37.8211	-90.5466003
2168	2168/8.2	Flat River Cr. just bl. Dry Cr.	37.8146	-90.5792999
2168	2168/4.5	Flat River Cr. just bl. Elvins TP trib.	37.8409	-90.5255966
2168	2168/2.6	Flat River Cr. just DS of National Chat Pile trib.	37.8631	-90.50485
2168	2168/0.8	Flat River Cr. near Mouth	37.8828	-90.5030975

Watershed	Site	Site Name	Latitude	Longitude
2168	2168/2.0	Flat River Cr. @ bl. National chat pile	37.8662	-90.5050964
2168	2168/5.9	Flat River Cr. @ Hwy B	37.8285	-90.5391998
2168	2168/3.9	Flat River Cr. @ Main St, Flat River, MO	37.8491	-90.5173035
2168	2168/4.4	Flat River Cr. @ Rivermines	37.844	-90.5239029
2168	2168/2.6/0.1	Seep from National Chat Pile	37.8597	-90.5086136
2168	2168/5.0/0.2	Trib. from Elvins chat pile	37.8398	-90.5289993
2170	2170/0.6	Shaw Br. @ St. Joe S. P.	37.8423	-90.5168991

Appendix F– Water quality data from the Big River Watershed

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2074/38.1	2074	COESTL	1/3/1977		290	0.499		
2074/38.1	2074	COESTL	11/28/1977			0.499		
2074/38.1	2074	COESTL	2/8/1978		274	2		
2074/38.1	2074	COESTL	2/16/1977			5		
2074/38.1	2074	COESTL	11/2/1976			7		
2074/38.1	2074	COESTL	10/12/1977		219	8		
2074/38.1	2074	COESTL	5/11/1976			10		
2074/38.1	2074	COESTL	5/11/1977			12		
2074/38.1	2074	COESTL	6/13/1977		234	12		
2074/38.1	2074	COESTL	9/14/1976	22		23		
2074/38.1	2074	COESTL	8/24/1978			13		
2074/38.1	2074	COESTL	8/29/1977			14		
2074/38.1	2074	COESTL	6/13/1978			15		
2074/38.1	2074	COESTL	7/26/1977			17		
2074/38.1	2074	COESTL	6/29/1976	250		28		
2074/38.1	2074	COESTL	3/21/1977		202	24		
2074/38.1	2074	COESTL	6/8/1976			30		
2074/38.1	2074	COESTL	8/3/1976			86		
2074/38.1	2074	COESTL	3/28/1977			342		
2074/44.7/1.2	2074	COESTL	1/3/1977	1	311	0.499		
2074/44.7/1.2	2074	COESTL	8/29/1977	1.5		0.499		
2074/44.7/1.2	2074	COESTL	10/12/1977	2.5	197	0.499		
2074/44.7/1.2	2074	COESTL	11/28/1977	3		0.499		
2074/44.7/1.2	2074	COESTL	5/11/1976	2		1		
2074/44.7/1.2	2074	COESTL	11/2/1976	1.5		1		
2074/44.7/1.2	2074	COESTL	5/11/1977	1		1		
2074/44.7/1.2	2074	COESTL	2/8/1978	1	241	1		

[14] The naming convention for these sites is: the WBID (water body identification number) of the segment/miles from the mouth of the segment/miles from the mouth of a tributary

[15] Hardness, TSS limits and observed data records are in mg/L; dissolved lead and dissolved zinc data and limits are in µg/L; flow is reported in ft^3/s unless otherwise noted.

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2074/44.7/1.2	2074	COESTL	6/13/1978	1		1		
2074/44.7/1.2	2074	COESTL	3/21/1977	4	164	2		
2074/44.7/1.2	2074	COESTL	6/13/1977	1.5	216	2		
2074/44.7/1.2	2074	COESTL	2/16/1977	2.5		3		
2074/44.7/1.2	2074	COESTL	6/29/1976	5		90		
2074/44.7/1.2	2074	COESTL	6/8/1976			3		
2074/44.7/1.2	2074	COESTL	3/28/1977			34		
2074/48.3	2074	COESTL	1/3/1977		290	0.499		
2074/48.3	2074	COESTL	11/28/1977			0.499		
2074/48.3	2074	COESTL	5/11/1977			1		
2074/48.3	2074	COESTL	2/16/1977			5		
2074/48.3	2074	COESTL	8/29/1977			7		
2074/48.3	2074	COESTL	10/12/1977		232	9		
2074/48.3	2074	COESTL	8/24/1978			9		
2074/48.3	2074	COESTL	2/8/1978	77	272	3		
2074/48.3	2074	COESTL	7/26/1977			13		
2074/48.3	2074	COESTL	5/11/1976			14		
2074/48.3	2074	COESTL	3/21/1977		184	23		
2074/48.3	2074	COESTL	6/8/1976			26		
2074/48.3	2074	COESTL	6/13/1977		234	26		
2074/48.3	2074	COESTL	11/2/1976	50		9		
2074/48.3	2074	COESTL	8/3/1976			76		
2074/48.3	2074	COESTL	3/28/1977			688		
2074/48.3	2074	COESTL	6/13/1978	85		12		
2074/48.3	2074	COESTL	9/14/1976	18		16		
2074/48.3	2074	COESTL	6/29/1976	250		68		
2074/53.0	2074	USGS	1/4/1995	406	250		0.499	1.99
2074/53.0	2074	USGS	7/18/1984	170	260	7	0.499	18
2074/53.0	2074	USGS	6/23/1994	476	280	10	0.499	11
2074/53.0	2074	USGS	1/10/1986	445	270	3	1	70
2074/53.0	2074	USGS	11/9/1992	153	290	0	2	6
2074/53.0	2074	USGS	7/12/1985	303	280	9	2	44
2074/53.0	2074	USGS	1/19/1993	551	200	18	2	47
2074/53.0	2074	USGS	11/29/2000	160	280	4.99	2.29	
2074/53.0	2074	USGS	1/13/1987	272	270	0	2.499	42
2074/53.0	2074	USGS	10/23/1986	231	270	1	2.499	23
2074/53.0	2074	USGS	4/9/1987	326	250	14	2.499	17
2074/53.0	2074	USGS	5/4/2005	656	230	4.99	2.66	8.3
2074/53.0	2074	USGS	11/3/2004	1660	190	58	2.9	7.9
2074/53.0	2074	USGS	11/7/2002	326	250	4.99	2.92	17
2074/53.0	2074	USGS	11/17/1983	201	270		3	20
2074/53.0	2074	USGS	1/11/1985	857	210	6	3	77
2074/53.0	2074	USGS	5/18/1993	3350	140	196	3	13
2074/53.0	2074	USGS	5/4/2004	1640	150	37	3.93	13

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2074/53.0	2074	USGS	1/27/1994	2000	160	2	4	24
2074/53.0	2074	USGS	1/14/1997	360	270	2	4	42
2074/53.0	2074	USGS	10/17/1985	193	310	11	4	20
2074/53.0	2074	USGS	5/15/2001	117	260	4.99	4.04	16
2074/53.0	2074	USGS	5/21/2003	551	240	4.99	4.13	6
2074/53.0	2074	USGS	11/15/2001	84	290	4.99	4.79	
2074/53.0	2074	USGS	11/12/2003	131	310	4.99	4.85	5
2074/53.0	2074	USGS	5/4/1989	303	230	7	4.99	28
2074/53.0	2074	USGS	3/3/1989	445	240	9	4.99	54
2074/53.0	2074	USGS	5/24/1994	671	230	9	4.99	19
2074/53.0	2074	USGS	2/24/1988	948	190		4.99	48
2074/53.0	2074	USGS	5/17/1988	174	270		4.99	21
2074/53.0	2074	USGS	9/27/1988	73	250	20	4.99	23
2074/53.0	2074	USGS	12/1/1988	510	190		4.99	36
2074/53.0	2074	USGS	8/24/1994	126	270	38	4.99	8
2074/53.0	2074	USGS	6/3/1996	377	240	2	5	4.8
2074/53.0	2074	USGS	4/4/1985	1690	170	28	5	41
2074/53.0	2074	USGS	9/14/1989	354	280		5	44
2074/53.0	2074	USGS	1/24/1996	2160	160	62	5	64
2074/53.0	2074	USGS	4/10/1986	601	260	2	6	10
2074/53.0	2074	USGS	6/14/1995	1070	160	6	6	15
2074/53.0	2074	USGS	4/19/1984	750	200	14	6	43
2074/53.0	2074	USGS	10/11/1984	249	250	0	7	26
2074/53.0	2074	USGS	7/11/1986	174	270	14	7	23
2074/53.0	2074	USGS	6/17/1997	1220	180	29	7	12
2074/53.0	2074	USGS	5/11/1995	1490	160	42	7	13
2074/53.0	2074	USGS	1/18/1984	203	250	0	9	92
2074/53.0	2074	USGS	5/15/2002	2760	140	53	15.7	49
2074/53.0	2074	USGS	6/3/1998	340	230	0.499	49.99	9.99
2074/53.0	2074	USGS	6/29/1999	289	250	1	49.99	12
2074/53.0	2074	USGS	11/22/1999	103	300	3	49.99	9.99
2074/53.0	2074	USGS	5/24/2000	93	280	4.99	49.99	9.99
2074/53.0	2074	USGS	1/12/1998	1140	180	9	49.99	21
2074/53.0	2074	USGS	1/19/1999	1760	140	103	49.99	28
2074/53.0	2074	USGS	2/13/1986	617		1		
2074/53.0	2074	USGS	5/10/1984	855		2		
2074/53.0	2074	USGS	12/20/1983	442		3		
2074/53.0	2074	USGS	9/19/1985	196		3		
2074/53.0	2074	USGS	8/15/1984	132		4		
2074/53.0	2074	USGS	2/6/1987	345		4		
2074/53.0	2074	USGS	9/4/2002	125		4.99		
2074/53.0	2074	USGS	1/8/2003	672		4.99		
2074/53.0	2074	USGS	7/23/2003	150		4.99		
2074/53.0	2074	USGS	9/4/2003	179		4.99		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2074/53.0	2074	USGS	1/21/2004	1000		4.99		
2074/53.0	2074	USGS	3/2/2004	278		4.99		
2074/53.0	2074	USGS	7/20/2004	121		4.99		
2074/53.0	2074	USGS	9/22/2004	98		4.99		
2074/53.0	2074	USGS	1/3/2005	367		4.99		
2074/53.0	2074	USGS	3/10/2005	394		4.99		
2074/53.0	2074	USGS	7/25/2005	152		4.99		
2074/53.0	2074	USGS	9/1/2005	138		4.99		
2074/53.0	2074	USGS	11/9/1984	577		5		
2074/53.0	2074	USGS	5/10/1985	656		5		
2074/53.0	2074	USGS	3/12/1986	617		6		
2074/53.0	2074	USGS	5/15/1987	212		6		
2074/53.0	2074	USGS	9/19/1984	154		7		
2074/53.0	2074	USGS	11/21/1986	298		7		
2074/53.0	2074	USGS	12/6/1984	738		8		
2074/53.0	2074	USGS	7/6/1993	319		8		
2074/53.0	2074	USGS	3/5/1987	798		9		
2074/53.0	2074	USGS	6/20/1984	258		10		
2074/53.0	2074	USGS	9/30/1993	1350		11		
2074/53.0	2074	USGS	3/5/2003	886		11		
2074/53.0	2074	USGS	8/27/1986	152		13		
2074/53.0	2074	USGS	2/23/1984	538		14		
2074/53.0	2074	USGS	6/12/1985	3460		14		
2074/53.0	2074	USGS	12/18/1986	393		16		
2074/53.0	2074	USGS	6/12/1986	743		18		
2074/53.0	2074	USGS	1/16/2002	156		18		
2074/53.0	2074	USGS	5/16/1986	1220		22		
2074/53.0	2074	USGS	3/13/2002	1430		28		
2074/53.0	2074	USGS	11/22/1985	2640		37		
2074/53.0	2074	USGS	3/14/1985	2210		51		
2074/53.0	2074	USGS	7/10/2002	173		54		
2074/53.0	2074	USGS	2/21/1985	2780		65		
2074/53.0	2074	USGS	8/7/1985	988		87		
2074/53.0	2074	USGS	3/21/1984	2890		106		
2074/53.0	2074	USGS	9/19/1986	1820		163		
2074/53.0	2074	USGS	12/12/1985	8060		243		
2074/9.2	2074	New Fields	9/27/2000		251		1.499	9.99
2074/9.2	2074	New Fields	9/28/1998		278		3	2.499
2074/9.2	2074	New Fields	9/18/1999		275		4	2.499
2077/0.4	2077	COESTL	3/21/1977	4	210	0.499		
2077/0.4	2077	COESTL	6/13/1977	2.5	227	0.499		
2077/0.4	2077	COESTL	7/26/1977	1.5		0.499		
2077/0.4	2077	COESTL	8/29/1977	4		0.499		
2077/0.4	2077	COESTL	10/12/1977	5	230	0.499		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2077/0.4	2077	COESTL	11/28/1977	8		0.499		
2077/0.4	2077	COESTL	5/11/1976	1.5		1		
2077/0.4	2077	COESTL	1/3/1977	2.5	274	1		
2077/0.4	2077	COESTL	2/16/1977	4		1		
2077/0.4	2077	COESTL	5/11/1977	2.5		1		
2077/0.4	2077	COESTL	2/8/1978	3	252	1		
2077/0.4	2077	COESTL	6/8/1976			2		
2077/0.4	2077	COESTL	11/2/1976	1.5		2		
2077/0.4	2077	COESTL	8/24/1978	1.5		2		
2077/0.4	2077	COESTL	6/13/1978	1.5		4		
2077/0.4	2077	COESTL	6/29/1976	3.5		34		
2077/0.4	2077	COESTL	3/28/1977			61		
2080/11.6	2080	MDNR	10/3/2002	90.4	287		3.6	4.99
2080/11.6	2080	COESTL	2/8/1978	62	282	2		
2080/11.6	2080	COESTL	2/15/1977	62		5		
2080/11.6	2080	COESTL	11/2/1976	12		6		
2080/11.6	2080	COESTL	11/28/1977			0.499		
2080/11.6	2080	COESTL	10/12/1977	45	229	8		
2080/11.6	2080	COESTL	1/5/1977		294	2		
2080/11.6	2080	COESTL	5/10/1977			7		
2080/11.6	2080	COESTL	5/11/1976			10		
2080/11.6	2080	COESTL	9/14/1976	13		11		
2080/11.6	2080	COESTL	3/22/1977		190	11		
2080/11.6	2080	COESTL	6/14/1977		237	11		
2080/11.6	2080	COESTL	7/26/1977			13		
2080/11.6	2080	COESTL	6/8/1976			20		
2080/11.6	2080	COESTL	8/31/1977	62		14		
2080/11.6	2080	COESTL	3/29/1977			445		
2080/11.6	2080	COESTL	6/13/1978	55		18		
2080/11.6	2080	COESTL	8/23/1978	62		26		
2080/11.6	2080	COESTL	8/4/1976	80		33		
2080/11.6	2080	COESTL	6/29/1976	150		41		
2080/20.4	2080	MDNR	10/2/2002	73.2	297		3.48	12
2080/20.4	2080	MDNR	4/3/2003		229		4.14	45.2
2080/30.2	2080	COESTL	11/29/1977			0.499		
2080/30.2	2080	COESTL	3/24/1977		192	2		
2080/30.2	2080	COESTL	6/9/1976			9		
2080/30.2	2080	COESTL	3/30/1977			61		
2080/30.2	2080	COESTL	1/4/1977	22	295	0.499		
2080/30.2	2080	COESTL	8/30/1977	52		0.499		
2080/30.2	2080	COESTL	2/7/1978	42	290	2		
2080/30.2	2080	COESTL	5/12/1976	4		3		
2080/30.2	2080	COESTL	5/10/1977	37		3		
2080/30.2	2080	COESTL	11/1/1976	7		4		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2080/30.2	2080	COESTL	10/11/1977	37	228	4		
2080/30.2	2080	COESTL	8/23/1978	22		4		
2080/30.2	2080	COESTL	7/27/1977	15		5		
2080/30.2	2080	COESTL	6/12/1978	27		5		
2080/30.2	2080	COESTL	6/30/1976	17		6		
2080/30.2	2080	COESTL	2/14/1977	42		6		
2080/30.2	2080	COESTL	6/15/1977	18	229	6		
2080/30.2	2080	COESTL	9/15/1976	12		10		
2080/30.2	2080	COESTL	8/4/1976	90		32		
2080/32.4	2080	MDNR	9/26/2002	86.8	264		4.23	56.6
2080/32.4	2080	MDNR	4/2/2003	253	234		5.25	99.5
2080/32.4	2080	New Fields	9/27/2000		329		6.5	17.6
2080/32.4	2080	New Fields	10/2/1998		354		7	34
2080/32.4	2080	New Fields	9/18/1999		380		7	49
2080/36.9	2080	MDNR	9/25/2002	84.9	261		5.87	92.9
2080/40.7	2080	COESTL	8/23/1978	16		3		
2080/40.7	2080	COESTL	2/7/1978	37	271	9		
2080/40.7	2080	COESTL	6/12/1978	27		14		
2080/41.9	2080	MDNR	9/24/2002	108	247		3.98	108
2080/41.9	2080	MDNR	4/2/2003	228	228		4.32	83.4
2080/41.9	2080	New Fields	9/30/1998		379		15	153
2080/41.9	2080	New Fields	9/16/1999		430		19	167
2080/41.9	2080	New Fields	9/25/2000		333		49.7	117
2080/42.5	2080	MDNR	4/2/2003	161	213		0.99	80.8
2080/42.5	2080	USGS	2/25/1988	257			4.99	110
2080/42.5	2080	USGS	5/16/1988	79			4.99	140
2080/42.5	2080	USGS	12/1/1988	254			4.99	100
2080/42.5	2080	MDNR	10/1/2002	45	304		6.8	168
2080/42.5	2080	MDNR	9/26/2002		264		4.14	143
2080/42.5	2080	COESTL	8/30/1977	42		0.499		
2080/42.5	2080	New Fields	9/30/1998		359		9	97
2080/42.5	2080	New Fields	9/16/1999		400		16	200
2080/42.5	2080	COESTL	11/29/1977	100		0.499		
2080/42.5	2080	New Fields	9/25/2000		307		44.3	140
2080/42.5	2080	USGS	3/3/1989	192		1	4.99	160
2080/42.5	2080	COESTL	1/4/1977		272	0.499		
2080/42.5	2080	USGS	9/13/1989	36		2	8	160
2080/42.5	2080	USGS	9/27/1988	69		2	10	130
2080/42.5	2080	COESTL	3/24/1977		180	0.499		
2080/42.5	2080	COESTL	6/9/1976			7		
2080/42.5	2080	COESTL	3/30/1977			31		
2080/42.5	2080	COESTL	6/15/1977	9	236	2		
2080/42.5	2080	COESTL	2/7/1978	33	260	2		
2080/42.5	2080	COESTL	6/12/1978	22		2		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2080/42.5	2080	COESTL	5/12/1976	15		3		
2080/42.5	2080	COESTL	5/10/1977	32		3		
2080/42.5	2080	COESTL	8/23/1978	15		3		
2080/42.5	2080	COESTL	6/30/1976	12		4		
2080/42.5	2080	COESTL	11/1/1976	22		4		
2080/42.5	2080	COESTL	2/14/1977	42		5		
2080/42.5	2080	COESTL	7/27/1977	15		5		
2080/42.5	2080	COESTL	9/15/1976	4		6		
2080/42.5	2080	USGS	5/4/1989	131		9	4.99	140
2080/42.5	2080	COESTL	10/11/1977	27	216	9		
2080/42.5	2080	COESTL	8/2/1976	80		24		
2080/42.5	2080	USGS	1/26/1989	155		31		
2080/45.4	2080	New Fields	9/28/2000		311		3.7	75.3
2080/45.4	2080	New Fields	9/17/1999		418		8	142
2080/45.4	2080	USGS	11/7/1989	44	330		4	150
2080/45.4	2080	USGS	10/26/1993	122	250		4.99	93
2080/48.58	2080	USGS	5/17/1988	0.01	780		4.99	250
2080/48.58	2080	USGS	3/2/1989	0.15	560		4.99	420
2080/48.58	2080	USGS	5/4/1989	0.05	690		4.99	220
2080/48.58	2080	USGS	2/24/1988	0.01	480		10	250
2080/48.58	2080	USGS	9/14/1989	0.15	250		18	120
2080/48.58	2080	USGS	12/1/1988	0.01	630		20	740
2080/48.58	2080	USGS	9/27/1988		650	1	10	420
2080/48.6	2080	USGS	11/7/1989	39.3	320		2	100
2080/48.6	2080	USGS	10/26/1993	119	240		4.99	60
2080/48.6	2080	USGS	5/17/1988	67	290		4.99	98
2080/48.6	2080	New Fields	9/25/2000		341		3.6	361
2080/48.6	2080	New Fields	9/16/1999		410		6	74
2080/48.6	2080	New Fields	9/27/1998		351		7	63
2080/48.6	2080	USGS	2/24/1988	285	170		10	120
2080/48.6	2080	USGS	11/30/1988	271	160		10	51
2080/48.6	2080	USGS	3/2/1989	185	200	2	4.99	55
2080/48.6	2080	USGS	9/27/1988	63	240	6	20	83
2080/48.6	2080	USGS	5/4/1989	134	220	7	4.99	69
2080/48.6	2080	USGS	9/14/1989	52	330	8	2	95
2080/48.6/0.1	2080	USGS	3/2/1989	0.15	560		4.99	420
2080/48.6/0.1	2080	USGS	5/4/1989	0.05	690		4.99	220
2080/48.6/0.1	2080	USGS	2/24/1988	0.01	480		13	250
2080/48.6/0.1	2080	USGS	9/14/1989	0.15	250		18	120
2080/48.6/0.1	2080	USGS	12/1/1988	0.01	630		20	740
2080/48.6/0.1	2080	USGS	5/17/1988	0.01	780		36	250
2080/48.6/0.1	2080	USGS	9/27/1988		650		10	420
2080/48.6/0.5	2080	USGS	4/26/1990		590		4.99	63
2080/48.6/0.5/.0	2080	USGS	4/26/1990		290		4.99	24

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2080/48.62	2080	USGS	9/14/1989	0.1	520		18	170
2080/48.62	2080	USGS	2/24/1988	0.2	560		20	290
2080/48.62	2080	USGS	5/17/1988	0.11	570		20	310
2080/48.62	2080	USGS	9/27/1988	0.1	540		20	200
2080/48.62	2080	USGS	5/4/1989	0.14	530		20	310
2080/48.62	2080	USGS	11/30/1988	0.11	540		30	210
2080/48.62	2080	USGS	3/2/1989	0.14	530		30	210
2080/55.6	2080	MDNR	10/1/2002	27.9	263		0.99	49.8
2080/55.6	2080	MDNR	4/2/2003	154	192		0.99	33.1
2080/58.8	2080	COESTL	11/29/1977			0.499		
2080/58.8	2080	COESTL	3/30/1977			17		
2080/58.8	2080	COESTL	3/22/1977	15	166	0.499		
2080/58.8	2080	COESTL	8/30/1977	42		0.499		
2080/58.8	2080	COESTL	1/4/1977	13	250	1		
2080/58.8	2080	COESTL	2/7/1978	25	253	1		
2080/58.8	2080	COESTL	11/1/1976	2		2		
2080/58.8	2080	COESTL	2/15/1977	32		2		
2080/58.8	2080	COESTL	8/22/1978	11		4		
2080/58.8	2080	COESTL	6/14/1977	14	217	5		
2080/58.8	2080	COESTL	10/11/1977	27	212	5		
2080/58.8	2080	COESTL	5/9/1977	16		6		
2080/58.8	2080	COESTL	6/30/1976	10		8		
2080/58.8	2080	COESTL	9/15/1976	3.5		8		
2080/58.8	2080	COESTL	7/27/1977	7		10		
2080/58.8	2080	COESTL	6/14/1978	19		13		
2080/58.8	2080	COESTL	8/2/1976	21		14		
2080/65.5	2080	MDNR	10/2/2002	20.1	209		0.99	4.99
2080/65.5	2080	MDNR	4/2/2003	122	162		0.99	4.99
2080/65.5	2080	USGS	2/23/1988	234	130		4.99	27
2080/65.5	2080	USGS	5/16/1988	58	190		4.99	8
2080/65.5	2080	New Fields	9/24/1998		256		0.499	2.499
2080/65.5	2080	New Fields	9/19/1999		279		0.499	2.499
2080/65.5	2080	New Fields	9/26/2000		217		1.499	9.99
2080/65.5	2080	COESTL	6/9/1976			8		
2080/65.5	2080	COESTL	3/1/1978	99	178	0.499		
2080/65.5	2080	USGS	9/13/1989	8.5	210	2	0.499	12
2080/65.5	2080	USGS	3/2/1989	264	160	4	4.99	18
2080/65.5	2080	USGS	5/3/1989	85	160	4	4.99	11
2080/65.5	2080	USGS	9/26/1988	75	180	5	4.99	8
2080/65.5	2080	COESTL	7/19/1978	43		5		
2080/65.5	2080	COESTL	8/22/1978	9.6		5		
2080/65.5	2080	COESTL	5/12/1976	22		6		
2080/65.5	2080	COESTL	5/4/1978	58		6		
2080/65.5	2080	COESTL	6/14/1978	16		6		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2080/65.5	2080	COESTL	1/5/1978	54		12		
2080/65.5	2080	USGS	11/30/1988	360	140	15	4.99	19
2080/68.3	2080	MDNR	4/4/2002	61.3	170		0.99	2.499
2080/68.3	2080	MDNR	9/20/2001	4.2	240		1.2499	2.499
2080/71.6	2080	MDNR	4/4/2002	54.5	160		0.99	2.499
2080/71.6	2080	MDNR	9/20/2001	4.7	240		1.2499	2.499
2080/71.6	2080	COESTL	6/9/1976			2		
2080/71.6	2080	COESTL	6/30/1976			2		
2080/71.6	2080	COESTL	5/4/1978			8		
2080/71.6	2080	COESTL	3/30/1977			11		
2080/71.6	2080	COESTL	3/22/1977	7	158	0.499		
2080/71.6	2080	COESTL	6/14/1977	11	237	0.499		
2080/71.6	2080	COESTL	8/30/1977	27		0.499		
2080/71.6	2080	COESTL	10/11/1977	11	222	0.499		
2080/71.6	2080	COESTL	11/29/1977	22		0.499		
2080/71.6	2080	COESTL	1/2/1978	15		0.499		
2080/71.6	2080	COESTL	2/7/1978	13	223	0.499		
2080/71.6	2080	COESTL	3/1/1978	27	194	0.499		
2080/71.6	2080	COESTL	5/12/1976	15		1		
2080/71.6	2080	COESTL	2/15/1977	22		1		
2080/71.6	2080	COESTL	7/27/1977	5.7		1		
2080/71.6	2080	COESTL	7/19/1978	0.499		1		
2080/71.6	2080	COESTL	8/22/1978	5.5		1		
2080/71.6	2080	COESTL	8/22/1978	5.5		1		
2080/71.6	2080	COESTL	1/4/1977	7	252	2		
2080/71.6	2080	COESTL	5/9/1977	11		2		
2080/71.6	2080	COESTL	6/14/1978	9		2		
2080/71.6	2080	COESTL	6/14/1978	9		2		
2080/71.6	2080	COESTL	11/1/1976	12		3		
2080/71.6	2080	COESTL	9/15/1976	3.5		6		
2080/73.4	2080	MDNR	4/4/2002	46.2	150		0.99	2.499
2080/73.4	2080	MDNR	9/20/2001	4	220		1.2499	2.499
2080/8.5	2080	MDNR	4/3/2003		238		9.96	27.1
2080/8.5	2080	MDNR	10/2/2002	102	268		5.64	4.99
2081/12.5	2801	MDNR	9/27/2005	47.2	249		0.125	3.09
2081/12.5	2801	MDNR	3/29/2006	79.1	192		0.125	3.21
2081/2.5	2801	MDNR	9/27/2005	70.6	245		0.125	4.39
2081/2.5	2801	MDNR	3/28/2006	135	200		0.125	2.86
2081/5.5	2081	COESTL	10/12/1977	27	234	0.499		
2081/5.5	2081	COESTL	11/28/1977	30		0.499		
2081/5.5	2081	COESTL	8/3/1976	10		1		
2081/5.5	2081	COESTL	1/5/1977	14	260	1		
2081/5.5	2081	COESTL	2/15/1977	27		1		
2081/5.5	2081	COESTL	3/22/1977	20	190	1		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2081/5.5	2081	COESTL	5/10/1977	24		1		
2081/5.5	2081	COESTL	2/8/1978	27	260	1		
2081/5.5	2081	COESTL	5/11/1976	13		2		
2081/5.5	2081	COESTL	6/8/1976			2		
2081/5.5	2081	COESTL	7/26/1977	10		2		
2081/5.5	2081	COESTL	9/14/1976	8		3		
2081/5.5	2081	COESTL	11/2/1976	20		3		
2081/5.5	2081	COESTL	6/29/1976	20		4		
2081/5.5	2081	COESTL	8/31/1977	27		4		
2081/5.5	2081	COESTL	6/14/1977	17	244	5		
2081/5.5	2081	COESTL	6/13/1978	32		5		
2081/5.5	2081	COESTL	8/23/1978	42		6		
2081/5.5	2081	COESTL	3/29/1977			60		
2084/1.8	2084	MDNR	9/27/2005	22.1	205		0.125	1.12
2084/1.8	2084	MDNR	3/29/2006	45.7	147		0.125	2.68
2111/1.4	2111	COESTL	3/22/1977	5	242	0.499		
2111/1.4	2111	COESTL	8/31/1977	5.5		0.499		
2111/1.4	2111	COESTL	10/11/1977	11	286	0.499		
2111/1.4	2111	COESTL	11/28/1977	12		0.499		
2111/1.4	2111	COESTL	2/8/1978	3.5	301	0.499		
2111/1.4	2111	COESTL	8/4/1976	4		1		
2111/1.4	2111	COESTL	5/10/1977	7		1		
2111/1.4	2111	COESTL	6/8/1976			2		
2111/1.4	2111	COESTL	6/29/1976	1.5		2		
2111/1.4	2111	COESTL	11/2/1976	4		2		
2111/1.4	2111	COESTL	1/5/1977	4.5	284	2		
2111/1.4	2111	COESTL	2/15/1977	8		2		
2111/1.4	2111	COESTL	7/26/1977	4		2		
2111/1.4	2111	COESTL	6/13/1978	3		2		
2111/1.4	2111	COESTL	9/14/1976	4		3		
2111/1.4	2111	COESTL	6/14/1977	7	262	4		
2111/1.4	2111	COESTL	8/23/1978	4.5		4		
2111/1.4	2111	COESTL	5/11/1976	3		6		
2111/1.4	2111	COESTL	3/29/1977			16		
2118/2.9	2118	MDNR	3/28/2006	37.6	189		0.125	6.34
2118/2.9	2118	MDNR	9/28/2005	3.14	244		1.61	5.69
2118/3.2	2118	COESTL	11/28/1977	22		0.499		
2118/3.2	2118	COESTL	1/5/1977	4.5	284	2		
2118/3.2	2118	COESTL	10/11/1977	11	236	2		
2118/3.2	2118	COESTL	2/7/1978	12	268	2		
2118/3.2	2118	COESTL	11/1/1976	5		3		
2118/3.2	2118	COESTL	3/22/1977	15	168	3		
2118/3.2	2118	COESTL	5/10/1977	6.5		3		
2118/3.2	2118	COESTL	7/26/1977	4		3		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2118/3.2	2118	COESTL	8/31/1977	13		3		
2118/3.2	2118	COESTL	6/13/1978	4		4		
2118/3.2	2118	COESTL	5/12/1976	50		5		
2118/3.2	2118	COESTL	6/14/1977	4.5	246	5		
2118/3.2	2118	COESTL	2/15/1977	11		6		
2118/3.2	2118	COESTL	6/9/1976			8		
2118/3.2	2118	COESTL	6/30/1976	3		8		
2118/3.2	2118	COESTL	8/23/1978	5.5		8		
2118/3.2	2118	COESTL	9/15/1976	3		12		
2118/3.2	2118	COESTL	8/4/1976	6		13		
2118/3.2	2118	COESTL	3/29/1977	65		28		
2118/8.5	2118	MDNR	9/28/2005	4.95	256		0.125	4.71
2118/8.5	2118	MDNR	3/28/2006	19.7	160		0.125	7.42
2140/0.4	2140	MDNR	4/4/2002		240		0.099	7.01
2140/0.4	2140	MDNR	9/20/2001		280		1.2499	2.499
2141/0.3	2141	COESTL	1/5/1978	5		0.499		
2141/0.3	2141	COESTL	3/1/1978	4	226	0.499		
2141/0.3	2141	COESTL	6/14/1978	1.5		0.499		
2141/0.3	2141	COESTL	7/19/1978	0.499		2		
2141/0.3	2141	COESTL	8/22/1978	1		5		
2141/0.3	2141	COESTL	5/4/1978	6		11		
2149/0.7	2149	COESTL	1/4/1978	1.5		0.499		
2149/0.7	2149	COESTL	3/1/1978	1.5	118	0.499		
2149/0.7	2149	COESTL	6/14/1978	1		0.499		
2149/0.7	2149	COESTL	5/4/1978	2.5		1		
2149/0.7	2149	COESTL	7/19/1978	0.499		2		
2152/1.7	2152	COESTL	1/5/1978	10		1		
2152/1.7	2152	COESTL	3/1/1978	22	152	1		
2152/1.7	2152	COESTL	5/4/1978	23		2		
2152/1.7	2152	COESTL	6/14/1978	4.5		4		
2152/1.7	2152	COESTL	8/2/1978	1.5		11		
2152/1.7	2152	COESTL	7/19/1978	0.499		19		
2157/1.7	2157	COESTL	1/4/1978	4		0.499		
2157/1.7	2157	COESTL	3/1/1978	9	155	0.499		
2157/1.7	2157	COESTL	5/4/1978	5.5		2		
2157/1.7	2157	COESTL	7/19/1978	0.499		2		
2157/1.7	2157	COESTL	6/14/1978	1		6		
2166/0.05	2166	MDNR	3/23/2004	1.5	422		3.83	1240
2166/0.05	2166	MDNR	10/1/2003	0.68	597		5.03	1720
2166/0.05	2166	MDNR	4/13/2006	2	375		5.55	1140
2166/0.2	2166	MDNR	2/16/2006	1.5			2.78	1090
2166/0.4	2166	MDNR	4/2/2003	3	426		0.99	1800
2166/0.4	2166	USGS	2/24/1988	0.86	310		4.99	820
2166/0.4	2166	USGS	5/16/1988	0.12	750		4.99	3100

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2166/0.4	2166	USGS	3/2/1989	1.3	370	4	4.99	720
2166/0.4	2166	USGS	5/3/1989	0.24	690	4	4.99	2200
2166/0.4	2166	USGS	9/13/1989	0.3	690	8	4	1800
2166/0.4	2166	USGS	9/26/1988	0.35	730	9	10	1200
2166/0.4	2166	USGS	12/10/1988	1.2	320	15	20	550
2168/0.8	2168	COESTL	3/24/1977	4.5	254	0.499		
2168/0.8	2168	COESTL	8/30/1977	5.5		0.499		
2168/0.8	2168	COESTL	11/29/1977	13		0.499		
2168/0.8	2168	COESTL	6/12/1978	3.5		1		
2168/0.8	2168	COESTL	5/12/1976	2		2		
2168/0.8	2168	COESTL	10/11/1977	3	334	2		
2168/0.8	2168	COESTL	2/7/1978	4	460	2		
2168/0.8	2168	COESTL	6/30/1976	0.499		3		
2168/0.8	2168	COESTL	11/1/1976	9		3		
2168/0.8	2168	COESTL	5/10/1977	1.5		3		
2168/0.8	2168	COESTL	1/4/1977	1.5	432	5		
2168/0.8	2168	COESTL	8/22/1978	1.5		6		
2168/0.8	2168	COESTL	6/9/1976			6		
2168/0.8	2168	COESTL	3/30/1977			88		
2168/0.8	2168	COESTL	8/2/1976	3		8		
2168/0.8	2168	COESTL	2/14/1977	2.5		11		
2168/2.0	2168	UMR-Pat	10/29/1998	7.7		0	0	279
2168/2.0	2168	UMR-Pat	11/28/1998	9.7		0	0	358
2168/2.0	2168	UMR-Pat	12/13/1998	24.3		0	0	262
2168/2.0	2168	UMR-Pat	4/11/1999	33.8		0	20	242
2168/2.0	2168	UMR-Pat	5/23/1999	12.9		0	33	232
2168/2.0	2168	UMR-Pat	6/6/1999	6.13		0	40	176
2168/2.0	2168	UMR-Pat	7/11/1999	2.73		0	42	104
2168/2.0	2168	UMR-Pat	7/18/1999	2.8		0	42	93
2168/2.0	2168	UMR-Pat	7/25/1999	2.35		0	45	95
2168/2.0	2168	UMR-Pat	8/2/1999	2.56		0	48	79
2168/2.0	2168	UMR-Pat	6/27/1999	5.6		0	50	136
2168/2.0	2168	USGS	5/3/1989	7.9	430	3	4.99	400
2168/2.0	2168	USGS	9/13/1989	3	520	3	13	110
2168/2.0	2168	USGS	2/25/1988	26	240		4.99	310
2168/2.0	2168	USGS	5/16/1988	6.3	380		10	360
2168/2.0	2168	USGS	10/29/1974	1.8	374		19	310
2168/2.0	2168	UMR-Kra10	7/30/1975		334		4.99	190
2168/2.0	2168	UMR-Kra10	6/4/1975		476		50	500
2168/2.0	2168	UMR-Kra10	7/2/1975		493		50	280
2168/2.0	2168	UMR-Kra10	6/13/1975		557		100	480
2168/2.0	2168	UMR-Kra10	6/19/1975		628		100	320
2168/2.0	2168	USGS	11/30/1988	22	250	11	20	330
2168/2.0	2168	USGS	1/26/1989	25		11		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2168/2.0	2168	USGS	9/26/1988	3.8	450	18	50	340
2168/2.0	2168	USGS	3/2/1989	24	270	22	4.99	310
2168/2.6	2168	MDNR	9/19/2001	3.1	470		11	34.4
2168/2.6	2168	New Fields	9/26/2000		440		5.49	75.9
2168/2.6	2168	New Fields	9/17/1999		516		21	88
2168/2.6	2168	New Fields	9/29/1998		517		28	64
2168/2.6/0.1	2168	USGS	2/25/1988	1.5	510		4.99	110
2168/2.6/0.1	2168	USGS	5/16/1988	1.3	540		4.99	140
2168/2.6/0.1	2168	USGS	9/26/1988	0.6	550		4.99	120
2168/2.6/0.1	2168	USGS	3/2/1989	0.86	540		4.99	51
2168/2.6/0.1	2168	USGS	5/3/1989	1.5	530		4.99	160
2168/2.6/0.1	2168	USGS	11/30/1988	1.1	530		20	150
2168/2.6/0.1	2168	USGS	9/14/1989		520		14	86
2168/3.1	2168	UMR-Kra9	7/30/1975		637		24.99	860
2168/3.1	2168	UMR-Kra9	6/4/1975		572		50	1280
2168/3.1	2168	UMR-Kra9	6/13/1975		616		50	1260
2168/3.1	2168	UMR-Kra9	6/19/1975		594		50	760
2168/3.1	2168	UMR-Kra9	7/2/1975		763		50	360
2168/3.6	2168	New Fields	9/26/2000		592		1.07	159
2168/3.6	2168	New Fields	9/19/1999		772		11	140
2168/3.6	2168	New Fields	9/29/1998		669		14	151
2168/3.9	2168	UMR-Pat	11/28/1998	0.33		0	0	935
2168/3.9	2168	UMR-Pat	8/2/1999	0.12		0	6	71
2168/3.9	2168	UMR-Pat	4/11/1999	21.2		0	7	306
2168/3.9	2168	UMR-Pat	7/18/1999	0.09		0	7	152
2168/3.9	2168	UMR-Pat	5/23/1999	8.64		0	8	495
2168/3.9	2168	UMR-Pat	7/25/1999	0.21		0	8	105
2168/3.9	2168	UMR-Pat	6/27/1999	0.68		0	9	391
2168/3.9	2168	UMR-Pat	6/6/1999	2.34		0	10	445
2168/3.9	2168	UMR-Pat	7/11/1999	0.27		0	10	234
2168/3.9	2168	MDNR-DPHP	9/30/1997	0.67	307	0.499	2	482
2168/3.9	2168	MDNR-DPHP	3/31/1997	0.02	316	0.499	2.499	194
2168/3.9	2168	MDNR-DPHP	9/30/1999	0.94	789	0.499	3.19	1580
2168/3.9	2168	MDNR-DPHP	9/30/2002	0.02	389	0.499	4.99	717
2168/3.9	2168	MDNR-DPHP	5/31/2003	6.67	313	0.499	4.99	28
2168/3.9	2168	MDNR-DPHP	5/31/2004	0.02	400	0.499	4.99	350
2168/3.9	2168	MDNR-DPHP	6/30/2001	2.67	254	0.499	49.99	230
2168/3.9	2168	MDNR-DPHP	2/28/2003	7.33	124	0.499	49.99	142
2168/3.9	2168	MDNR-DPHP	5/31/1999	0.06	495	0.499	72.4	24.99
2168/3.9	2168	MDNR-DPHP	9/30/1998	0.22	319	0.499	249.99	354
2168/3.9	2168	MDNR-DPHP	6/30/1997	0.7	359	1.6	6	543
2168/3.9	2168	MDNR-DPHP	5/31/2002	3.47	317	2	4.99	2058
2168/3.9	2168	MDNR-DPHP	9/30/2001	0.67	502	2	49.99	621
2168/3.9	2168	MDNR-DPHP	5/31/2000	2.68	259	3	4.99	221

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2168/3.9	2168	MDNR	9/20/2001	0.8	740		1.2499	622
2168/3.9	2168	MDNR-DPHP	6/30/2004	3.33	277	3.499	110	537
2168/3.9	2168	MDNR-DPHP	6/30/2000	1.12	321	4.7	14.499	190
2168/3.9	2168	MDNR-DPHP	6/30/2002	4	139	5	4.99	1775
2168/3.9	2168	MDNR-DPHP	2/29/2004	3.33	194	5	4.99	468
2168/3.9	2168	MDNR-DPHP	2/28/1998	107.1	101	6.5	10.9	57.6
2168/3.9	2168	MDNR-DPHP	9/30/2000	0.05	381	6.7	12.499	1350
2168/3.9	2168	UMR-Pat	12/13/1998	9		7.5	0	753
2168/3.9	2168	MDNR-DPHP	6/30/2003	0.93	269	8	4.99	331
2168/3.9	2168	UMR-Pat	10/29/1998			0	0	817
2168/3.9	2168	MDNR-DPHP	5/31/2005		480	2	10	363
2168/3.9	2168	MDNR-DPHP	6/30/2005		300	8	13	695
2168/3.9	2168	UMR-Kra8	6/4/1975		588		50	900
2168/3.9	2168	UMR-Kra8	6/13/1975		653		50	860
2168/3.9	2168	UMR-Kra8	6/19/1975		608		50	1260
2168/3.9	2168	UMR-Kra8	7/30/1975		528		50	1400
2168/3.9	2168	UMR-Kra8	7/2/1975		889		150	920
2168/3.9	2168	MDNR-DPHP	2/28/2005		180	171	300	204
2168/3.9	2168	MDNR-DPHP	6/30/1998	0.03	385	10.4	2.4	212
2168/3.9	2168	MDNR-DPHP	9/30/2005	0.17	180	12	15	139
2168/3.9	2168	MDNR-DPHP	2/29/2000	0.67	95	18	10.9	56.8
2168/3.9	2168	MDNR-DPHP	2/28/2002	8	379	18	49.99	700
2168/3.9	2168	MDNR-DPHP	5/31/1998	8.93	122	37	4.72	11.9
2168/3.9	2168	MDNR-DPHP	6/30/1999	0.004	686	37.3	55.7	233
2168/3.9	2168	MDNR-DPHP	5/31/1997	1.55	133	54	4	124
2168/3.9	2168	MDNR-DPHP	2/28/1999	0.09	540	81	25.2	49.99
2168/3.9	2168	MDNR-DPHP	5/31/2001	26.67	225	135	12.499	110
2168/3.9	2168	MDNR-DPHP	2/28/2006	3.33	100	171	6	65
2168/4.4	2168	MDNR-DPHP	6/30/1998	0.11	171	0.499	2.1	49.99
2168/4.4	2168	MDNR-DPHP	3/31/1997	0.08	450	0.499	2.499	69
2168/4.4	2168	MDNR-DPHP	9/30/1997	2.68	389	0.499	4.6	1420
2168/4.4	2168	MDNR-DPHP	2/28/1999	0.1	1030	0.499	4.99	49.99
2168/4.4	2168	MDNR-DPHP	5/31/2003	6.67	273	0.499	4.99	4.99
2168/4.4	2168	MDNR-DPHP	2/29/2004	1.6	153	0.499	4.99	175
2168/4.4	2168	MDNR-DPHP	5/31/2004	0.67	250	0.499	4.99	9.99
2168/4.4	2168	MDNR-DPHP	9/30/1999	0.67	705	0.499	5.78	819
2168/4.4	2168	MDNR-DPHP	5/31/2001	2.78	495	0.499	12.499	240
2168/4.4	2168	MDNR-DPHP	6/30/2001	0.4	281	0.499	49.99	300
2168/4.4	2168	MDNR-DPHP	2/28/2002	8	323	0.499	49.99	170
2168/4.4	2168	MDNR-DPHP	6/30/2002	2.67	124	0.499	49.99	1798
2168/4.4	2168	MDNR-DPHP	9/30/2002	0.01	385	0.499	49.99	1088
2168/4.4	2168	MDNR-DPHP	5/31/2002	2.13	339	1	49.99	2526
2168/4.4	2168	MDNR-DPHP	6/30/1997	0.7	376	1.2	5	525
2168/4.4	2168	MDNR-DPHP	6/30/1999	0.002	189	1.3	2.499	4.99

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2168/4.4	2168	MDNR-DPHP	5/31/1999	0.06	203	1.3	2.96	24.99
2168/4.4	2168	MDNR-DPHP	6/30/2000	0.22	330	1.6	14.499	218
2168/4.4	2168	MDNR-DPHP	5/31/2000	4.02	276	2	4.99	455
2168/4.4	2168	MDNR-DPHP	2/28/2003	7.33	146	2.7		90
2168/4.4	2168	MDNR-DPHP	9/30/2001	0.67	453	3.3	49.99	712
2168/4.4	2168	MDNR-DPHP	6/30/2004	1.33	189	3.499	2.499	2.499
2168/4.4	2168	MDNR-DPHP	9/30/1998	3.35	239	4.7	249.99	49.99
2168/4.4	2168	MDNR-DPHP	5/31/1997	1.55	126	5	5	164
2168/4.4	2168	MDNR-DPHP	2/29/2000	80.35	83	6	0.99	60.6
2168/4.4	2168	MDNR-DPHP	9/30/2003	26.67	100	6	4.99	143
2168/4.4	2168	MDNR-DPHP	6/30/2003	1.33	198	7	4.99	4.99
2168/4.4	2168	MDNR-DPHP	10/31/2005	0.17	200	7	13	160
2168/4.4	2168	MDNR-DPHP	5/31/2005		260	2	2.499	2.499
2168/4.4	2168	MDNR-DPHP	6/30/2005		160	2	2.499	2.499
2168/4.4	2168	New Fields	9/27/2000		697		5.8	448
2168/4.4	2168	New Fields	9/17/1999		783		6	646
2168/4.4	2168	New Fields	9/29/1998		779		7	676
2168/4.4	2168	MDNR-DPHP	2/28/2005		120	10	2.499	2.499
2168/4.4	2168	MDNR-DPHP	9/30/2000	0.11	517	11.7	12.499	1350
2168/4.4	2168	MDNR-DPHP	2/28/1998	133.9	138	13.5	15.1	634
2168/4.4	2168	MDNR-DPHP	2/28/2006	1.33	100	24	5	38
2168/4.4	2168	MDNR-DPHP	5/31/1998	8.93	95	36	3.79	8.2
2168/4.5	2168	MDNR	9/20/2001	0.3	360		1.2499	754
2168/4.5	2168	UMR-Kra7	7/30/1975		832		24.99	4800
2168/4.5	2168	UMR-Kra7	6/4/1975		640		50	3000
2168/4.5	2168	UMR-Kra7	6/13/1975		671		50	3200
2168/4.5	2168	UMR-Kra7	6/19/1975		792		100	3400
2168/4.5	2168	UMR-Kra7	7/2/1975		903		150	4100
2168/4.6	2168	UMR-Kra6	6/4/1975		196		24.99	4.99
2168/4.6	2168	UMR-Kra6	6/13/1975		212		24.99	10
2168/4.6	2168	UMR-Kra6	6/19/1975		212		24.99	4.99
2168/4.6	2168	UMR-Kra6	7/2/1975		209		24.99	4.99
2168/4.6	2168	UMR-Kra6	7/30/1975		189		24.99	4.99
2168/5.0/0.2	2168	UMR-Pat	10/29/1998	0.3		0	55	12100
2168/5.0/0.2	2168	UMR-Pat	7/11/1999	0.44		0	74	7519
2168/5.0/0.2	2168	UMR-Pat	8/2/1999	0.33		0	74	6370
2168/5.0/0.2	2168	UMR-Pat	6/27/1999	0.45		0	77	7159
2168/5.0/0.2	2168	UMR-Pat	7/25/1999	0.38		0	79	6000
2168/5.0/0.2	2168	UMR-Pat	6/6/1999	0.64		0	87	6840
2168/5.0/0.2	2168	UMR-Pat	12/13/1998	0.33		0	102	16100
2168/5.0/0.2	2168	UMR-Pat	4/11/1999	0.6		0	106	12000
2168/5.0/0.2	2168	USGS	3/2/1989	0.36	860	3	10	9100
2168/5.0/0.2	2168	USGS	5/16/1988	0.24	800		20	5600
2168/5.0/0.2	2168	USGS	2/23/1988	0.56	630		50	14000

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2168/5.0/0.2	2168	USGS	9/26/1988	0.24	940		50	3500
2168/5.0/0.2	2168	USGS	5/3/1989		750	2	20	6400
2168/5.0/0.2	2168	USGS	1/26/1989		870	5	20	10000
2168/5.0/0.2	2168	USGS	9/14/1989		840		44	8400
2168/5.0/0.2	2168	UMR-Pat	6/24/1993		540		70	15000
2168/5.0/0.2	2168	UMR-Pat	3/31/1993		630		80	15000
2168/5.0/0.2	2168	UMR-KraI2	6/13/1975		1296		100	9200
2168/5.0/0.2	2168	UMR-KraI2	7/30/1975		1325		100	7800
2168/5.0/0.2	2168	UMR-KraI2	6/4/1975		1288		150	700
2168/5.0/0.2	2168	UMR-Pat	11/28/1998	0.33		12	0	13700
2168/5.0/0.2	2168	USGS	11/30/1988	0.34	920	12	60	12000
2168/5.0/0.2	2168	UMR-Pat	7/18/1999	0.41		12	69	5421
2168/5.0/0.2	2168	UMR-Pat	5/23/1999	1.25		14	85	9579
2168/5.0/0.2	2168	UMR-KraI2	6/19/1975		1400		150	8600
2168/5.0/0.2	2168	UMR-KraI2	7/2/1975		1488		150	8200
2168/5.9	2168	MDNR-DPHP	5/31/1997	1.55	99	0.499	0.99	19
2168/5.9	2168	MDNR-DPHP	9/30/1997	6.48	305	0.499	0.99	7.499
2168/5.9	2168	MDNR-DPHP	6/30/1998	0.11	188	0.499	1.9	49.99
2168/5.9	2168	MDNR-DPHP	6/30/1997	0.7	279	0.499	2	9.99
2168/5.9	2168	MDNR-DPHP	6/30/1999	0.002	202	0.499	2.499	4.99
2168/5.9	2168	MDNR-DPHP	5/31/1999	0.05	185	0.499	3.84	24.99
2168/5.9	2168	MDNR-DPHP	5/31/2000	4.02	144	0.499	4.99	49.99
2168/5.9	2168	MDNR-DPHP	5/31/2003	6.67	281	0.499	4.99	26
2168/5.9	2168	MDNR-DPHP	5/31/2004	0.67	220	0.499	4.99	9.99
2168/5.9	2168	MDNR-DPHP	9/30/1999	0.54	238	0.499	9.95	49.99
2168/5.9	2168	MDNR-DPHP	6/30/2001	0.53	186	0.499	49.99	16
2168/5.9	2168	MDNR-DPHP	2/28/2002	2	240	0.499	49.99	40
2168/5.9	2168	MDNR-DPHP	5/31/2002	2.13	191	0.499	49.99	4.99
2168/5.9	2168	MDNR-DPHP	9/30/2002	0.02	195	0.499	49.99	4.99
2168/5.9	2168	MDNR-DPHP	2/28/2003	7.33	138	0.499	49.99	4.99
2168/5.9	2168	MDNR-DPHP	2/28/1999	0.08	422	1	4.99	49.99
2168/5.9	2168	MDNR-DPHP	2/29/2004	3.34	153	1	4.99	145
2168/5.9	2168	MDNR-DPHP	9/30/2001	0.67	359	1.3	49.99	6
2168/5.9	2168	MDNR-DPHP	6/30/2000	0.18	221	2	14.499	49.99
2168/5.9	2168	MDNR-DPHP	6/30/2003	1.33	214	3	4.99	4.99
2168/5.9	2168	USGS	9/13/1989	0.18	240		0.499	9
2168/5.9	2168	MDNR-DPHP	5/31/2001	40	309	3	12.499	49.99
2168/5.9	2168	MDNR	9/20/2001	0.7	210		1.2499	2.499
2168/5.9	2168	MDNR-DPHP	2/29/2000	67	76	4	0.99	19.3
2168/5.9	2168	MDNR-DPHP	9/30/2000	0.11	242	5	12.499	24.99
2168/5.9	2168	USGS	2/23/1988	19	120		4.99	1.499
2168/5.9	2168	USGS	5/16/1988	3.4	180		4.99	16
2168/5.9	2168	USGS	11/30/1988	16	140		4.99	11
2168/5.9	2168	USGS	3/2/1989	13	160		4.99	14

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2168/5.9	2168	USGS	5/3/1989	2.6	210		4.99	9
2168/5.9	2168	MDNR-DPHP	2/28/1998	26.8	97	5.5	4.99	14.4
2168/5.9	2168	MDNR-DPHP	6/30/2005		160	6	2.499	2.499
2168/5.9	2168	MDNR-DPHP	2/28/2005		100	10	2.499	2.499
2168/5.9	2168	MDNR-DPHP	2/28/2006	3.33	100	9	2.499	2.499
2168/5.9	2168	MDNR-DPHP	6/30/2002	2.67	85	10	49.99	2.499
2168/5.9	2168	MDNR-DPHP	5/31/1998	4.46	104	22	3.16	4.45
2168/5.9	2168	MDNR-DPHP	9/30/1998	0.11	219	23.3	249.99	49.99
2168/5.9	2168	MDNR-DPHP	6/30/2004	2.67	172	25	2.499	2.499
2168/6.0	2168	UMR-Pat	10/29/1998	3.05		0	0	75
2168/6.0	2168	UMR-Pat	11/28/1998	3.78		0	0	76
2168/6.0	2168	UMR-Pat	12/13/1998	10.1		0	0	216
2168/6.0	2168	UMR-Pat	6/27/1999	1.98		0	0	23
2168/6.0	2168	New Fields	9/16/1999		223		0.499	2.499
2168/6.0	2168	New Fields	9/26/1998		228		1	2.499
2168/6.0	2168	UMR-Kra5	6/4/1975		200		24.99	4.99
2168/6.0	2168	UMR-Kra5	6/13/1975		212		24.99	20
2168/6.0	2168	UMR-Kra5	6/19/1975		208		24.99	4.99
2168/6.0	2168	USGS	10/29/1974	0.83	224		4	110
2168/6.0	2168	UMR-Kra5	7/2/1975		211		24.99	4.99
2168/6.0	2168	UMR-Kra5	7/30/1975		193		24.99	4.99
2168/6.3	2168	UMR-Kra4	6/4/1975		180		24.99	4.99
2168/6.3	2168	UMR-Kra4	6/13/1975		212		24.99	30
2168/6.3	2168	UMR-Kra4	6/19/1975		208		24.99	4.99
2168/6.3	2168	UMR-Kra4	7/2/1975		214		24.99	4.99
2168/6.3	2168	UMR-Kra4	7/30/1975		199		24.99	4.99
2168/7.6	2168	UMR-Kra3	6/4/1975		204		24.99	4.99
2168/7.6	2168	UMR-Kra3	6/13/1975		212		24.99	20
2168/7.6	2168	UMR-Kra3	6/19/1975		200		24.99	4.99
2168/7.6	2168	UMR-Kra3	7/2/1975		201		24.99	4.99
2168/7.6	2168	UMR-Kra3	7/30/1975		182		24.99	4.99
2168/8.2	2168	MDNR	9/20/2001	0.4	220		1.2499	2.499
2168/8.2	2168	UMR-Kra2	6/4/1975		252		24.99	4.99
2168/8.2	2168	UMR-Kra2	6/13/1975		214		24.99	80
2168/8.2	2168	UMR-Kra2	6/19/1975		216		24.99	10
2168/8.2	2168	UMR-Kra2	7/2/1975		209		24.99	4.99
2168/8.2	2168	UMR-Kra2	7/30/1975		189		24.99	4.99
2168/8.8	2168	UMR-Kra1	6/4/1975		220		24.99	4.99
2168/8.8	2168	UMR-Kra1	6/13/1975		224		24.99	80
2168/8.8	2168	UMR-Kra1	6/19/1975		204		24.99	4.99
2168/8.8	2168	UMR-Kra1	7/2/1975		216		24.99	4.99
2168/8.8	2168	UMR-Kra1	7/30/1975		199		24.99	4.99
2170/0.6	2170	MDNR-DPHP	6/30/1997	0.27	426	1.2	23	419
2170/0.6	2170	MDNR-DPHP	6/30/2001	0.02	561	2.7	49.99	35

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
2170/0.6	2170	MDNR-DPHP	6/30/1998	0.01	281	4.4	6.6	49.99
2170/0.6	2170	MDNR-DPHP	10/31/2005	0.03	320	10	49	27
2170/0.6	2170	MDNR-DPHP	9/30/1997	0.04	412	16.4	7.1	7.499
2170/0.6	2170	MDNR-DPHP	3/31/1997	0.01	330	18.4	2.499	4.99
2170/0.6	2170	MDNR-DPHP	9/30/2000	0.01	605	30.8	12.499	24.99
2170/0.6	2170	MDNR-DPHP	2/28/2002	2	465	44	49.99	120
2170/0.6	2170	MDNR-DPHP	6/30/2002	2.67	196	45	4.99	68
2170/0.6	2170	MDNR-DPHP	6/30/2000	0.8	236	51	14.499	49.99
2170/0.6	2170	MDNR-DPHP	5/31/1997	0.31	206	53	11	56
2170/0.6	2170	MDNR-DPHP	2/29/2000	0.67	237	61	15.8	98.1
2170/0.6	2170	MDNR-DPHP	10/31/2003	2.67	185	92	26	248
2170/0.6	2170	MDNR-DPHP	2/28/1999	0.08	885	93	24.3	49.99
2170/0.6	2170	MDNR-DPHP	5/31/1998	0.07	184	105	13.9	26.7
2170/0.6	2170	MDNR-DPHP	2/28/2006		160	162	130	126
2170/0.6	2170	MDNR-DPHP	5/31/2001	6.67	201	185	12.499	49.99
2170/0.6	2170	MDNR-DPHP	2/28/1998	26.78	135	260	50.3	76.8
2170/0.6	2170	MDNR-DPHP	2/28/2005		180	298	420	257
2177/0.2	2177	USGS	11/10/1992	1.4	270	0.499	3	100
2177/0.2	2177	USGS	3/16/1993	9.8		0.499		
2177/0.2	2177	USGS	1/17/1996	1.5	220	1	5	93
2177/0.2	2177	USGS	6/25/1996	1.9	260	1	5	130
2177/0.2	2177	USGS	9/29/1993	3.2		1		
2177/0.2	2177	USGS	1/27/1994	12	160	2	6	76
2177/0.2	2177	USGS	1/11/1995	2.6	260	2	6	110
2177/0.2	2177	USGS	5/18/1993	8.5	190	3	3	70
2177/0.2	2177	USGS	6/18/1997	10	140	3	5	66
2177/0.2	2177	USGS	1/28/1997	10	110	4	4	82
2177/0.2	2177	USGS	6/8/1995	3	250	8	6	110
2177/0.2	2177	USGS	1/20/1993	10	210	10	3	89
2177/0.2	2177	USGS	6/24/1994	2.4	280	10	5	95
2177/0.2	2177	USGS	7/7/1993	198		13		
3282/0.1	3282	MDNR	7/30/1985			37		
3282/0.3	3282	MDNR	8/29/2002	2.7		8		
3282/0.3	3282	MDNR	7/24/2002	0.66		11		
3282/0.3	3282	MDNR	8/29/2002	2.6		11		
3282/0.3	3282	MDNR	7/23/2002			2.499		
3282/0.3	3282	MDNR	8/28/2002			2.499		
3282/0.3	3282	MDNR	7/24/2002			5		
3282/0.3	3282	MDNR	8/28/2002			7		
3282/0.3	3282	MDNR	4/13/2006	2.4	329		4.89	50.6
3282/0.3	3282	MDNR	6/28/2001	1.6			7.6	20.6
3282/0.3	3282	MDNR	7/2/2002	1.2			16.8	167
3282/0.3	3282	MDNR	7/10/2003	0.5			17.2	37.8
3282/0.3	3282	MDNR	9/3/2002	2.7			24.3	90.2

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
3282/0.3	3282	MDNR	7/23/2002			14		
3282/0.6/0.1	3282	MDNR	8/28/2002			5		
3282/0.6/0.1	3282	MDNR	7/23/2002			7		
3282/0.6/0.1	3282	MDNR	8/29/2002			8		
3282/0.6/0.1	3282	MDNR	7/24/2002			9		
3282/0.6/0.1	3282	MDNR	7/24/2002			9		
3282/0.6/0.1	3282	MDNR	7/23/2002			10		
3282/0.6/0.1	3282	MDNR	8/28/2002			11		
3282/0.6/0.1	3282	MDNR	8/29/2002	0.08		10		
3282/1.0	3282	MDNR	7/24/2002	0.26		8		
3282/1.0	3282	MDNR	8/29/2002	3.1		8		
3282/1.0	3282	MDNR	7/24/2002			9		
3282/1.0	3282	MDNR	7/30/1985			41		
3282/1.0	3282	MDNR	8/29/2002	2.7		10		
3282/1.0	3282	MDNR	6/16/2004	7.5			6.75	22.6
3282/1.0	3282	MDNR	2/16/2006	3			10.3	77.6
3282/1.0	3282	MDNR	6/30/2004	7			20.7	54.9
3282/1.0	3282	MDNR	5/5/2005	4				82.9
3282/1.0	3282	MDNR	6/25/2005	3.4				21.2
3282/1.0	3282	MDNR	6/29/2005	0.5				44.1
3282/1.1/0.1	3282	MDNR	7/24/2002	0.004		7		
3282/1.1/0.1	3282	MDNR	7/23/2002			6		
3282/1.1/0.1	3282	MDNR	8/28/2002			7		
3282/1.1/0.1	3282	MDNR	7/24/2002			8		
3282/1.1/0.1	3282	MDNR	7/23/2002			8		
3282/1.1/0.1	3282	MDNR	8/28/2002			12		
3282/1.1/0.1	3282	MDNR	8/29/2002			14		
3282/1.1/0.1	3282		7/30/1985			41		
3282/1.1/0.1	3282	MDNR	8/29/2002	0.04		10		
3282/1.1/0.1	3282	MDNR	7/10/2003	0.3			1.215	29.7
3282/1.1/0.1	3282	MDNR	6/16/2004	2			1.44	89.6
3282/1.1/0.1	3282	MDNR	6/30/2004	1			2.2	44.4
3282/1.1/0.1	3282	MDNR	7/2/2002	0.8			3.6	512
3282/1.1/0.1	3282	MDNR	9/3/2002	0.8			17.1	40.5
3282/1.1/0.1	3282	MDNR	5/5/2005	1				37.1
3282/1.1/0.1	3282	MDNR	6/25/2005	0.3				40.6
3282/1.1/0.1	3282	MDNR	6/29/2005	0.3				45.5
3282/1.2/0.1	3282	MDNR	2/16/2006	1.2			1.57	48
3282/1.2/0.3	3282	MDNR	8/28/2002			2.499		
3282/1.2/0.3	3282	MDNR	7/23/2002			6		
3282/1.2/0.3	3282	MDNR	8/28/2002			8		
3282/1.2/0.3	3282	MDNR	2/4/2004			9		
3282/1.2/0.3	3282	MDNR	8/29/2002			10		
3282/1.2/0.3	3282	MDNR	7/23/2002			41		

Site[14]	WBID	Org	Date	Flow	Hard	TSS	DPb	DZn[15]
3282/1.2/0.3	3282	MDNR	7/24/2002			124		
3282/1.2/0.3	3282	MDNR	8/29/2002	0.5		10		
3282/1.2/0.3	3282	MDNR	7/24/2002	0.2		28		
3282/1.4	3282	MDNR	7/24/2002	0		5		
3282/1.4	3282	MDNR	8/29/2002	1.8		7		
3282/1.4	3282	MDNR	8/29/2002	1.8		8		
3282/1.4	3282	MDNR	7/30/1985			1		
3282/1.4	3282	MDNR	8/28/2002			5		
3282/1.4	3282	MDNR	7/24/2002			6		
3282/1.4	3282	MDNR	8/28/2002			8		
3282/1.4	3282	MDNR	7/23/2002			10		
3282/1.4	3282	MDNR	7/23/2002			27		
3282/1.4	3282	MDNR	6/16/2004	5			4.16	33.5
3282/1.4	3282	MDNR	4/13/2006	0.15	754		21.1	323
3282/1.4	3282	MDNR	6/30/2004	3			37	126
3282/1.4	3282	MDNR	9/3/2002	1.1			39.6	201
3282/1.4	3282	MDNR	7/10/2003	0.1			40.7	313
3282/1.4	3282	MDNR	5/5/2005	3				167
3282/1.4	3282	MDNR	6/25/2005	2.9				107
3282/1.4	3282	MDNR	6/29/2005	0				61.8
3282/1.8	3282	MDNR	6/16/2004	4			5.63	73
3282/1.8	3282	MDNR	7/10/2003	0.1			25.1	102
3282/1.8	3282	MDNR	2/16/2006	1.8			29.7	143
3282/1.8	3282	MDNR	7/2/2002	0.05			36.2	201
3282/1.8	3282	MDNR	6/30/2004	2.5			40.2	173
3282/1.8	3282	MDNR	6/28/2001	0.1			42.4	246
3282/1.8	3282	MDNR	9/3/2002	1			109	286
3282/1.8	3282	MDNR	5/5/2005	3				203
3282/1.8	3282	MDNR	6/25/2005	2.8				186
3282/1.8	3282	MDNR	6/29/2005	0				277
3282/1.8	3282	MDNR	8/28/2002			2.499		
3282/1.8	3282	MDNR	7/23/2002			5		
3282/1.8	3282	MDNR	8/28/2002			5		
3282/1.8	3282	MDNR	7/23/2002			6		
3282/2.2	3282	MDNR	8/28/2002			8		
3282/2.2	3282	MDNR	8/28/2002			10		
3282/2.2	3282	MDNR	8/29/2002	0.04		11		
3282/2.2	3282	MDNR	8/29/2002	0.09		15		

Appendix G – Fish Tissue Data for Big River and Its Tributaries
(Note: Units for the metals are mg/kg)

Site	Site Name	WBID	YEAR	SPECIES [16]	Pb	Cd	Hg
2080/5.2	Big River near Desoto	2080	1987	B RED	.043		
2080/5.2	Big River near Desoto	2080	1991	B RED	.870		.017
2168/0.8	Flat River Cr. nr. Mouth	2168	1995	B RED	.660	.024	.040
2168/0.8	Flat River Cr. nr. Mouth	2168	2000	BASS	.05	LT .006	.021
2080/5.2	Big River near Desoto	2080	1987	CARP	.380		
2080/5.2	Big River near Desoto	2080	1991	CARP	.440		.120
2074/20.0	Big R. @ Cedar Hill Access	2074	1987	CH CAT	.180		
2080/5.2	Big River near Desoto	2080	1990	CH CAT	.066		.037
2080/5.2	Big River near Desoto	2080	1991	CH CAT	.018		.018
2080/5.2	Big River near Desoto	2080	1992	CH CAT	.150		.020
2080/5.2	Big River near Desoto	2080	1993	CH CAT	.051		.013
2080/5.2	Big River near Desoto	2080	1994	CH CAT	.074		.024
2080/5.2	Big River near Desoto	2080	1995	CH CAT	.061	.007	.011
2080/5.2	Big River near Desoto	2080	1996	CH CAT	.062	.011	.024
2080/5.2	Big River near Desoto	2080	1992	FH CAT	.030		.034
2074/20.0	Big R. @ Cedar Hill Access	2074	1987	G RED	.035		
2080/5.2	Big River near Desoto	2080	1990	G RED	.400		.018
2080/5.2	Big River near Desoto	2080	1993	G RED	.670		.027
2080/5.2	Big River near Desoto	2080	1994	G RED	.430		.035
2080/5.2	Big River near Desoto	2080	1995	G RED	.29	.024	.034
2080/5.2	Big River near Desoto	2080	1996	G RED	.290		.034
2080/5.2	Big River near Desoto	2080	1996	G RED	.340	.019	.024
2074/20.0	Big R. @ Cedar Hill Access	2074	1997	G RED	.270	.018	.045
2080/5.2	Big River near Desoto	2080	1997	G RED	.710	.027	.034
2080/5.2	Big River near Desoto	2080	1999	G RED	.695		LT .018
2080/5.2	Big River near Desoto	2080	2002	G RED	.326	LT .06	LT .018
2074/20.0	Big R. @ Cedar Hill Access	2074	1998	K BASS	.06	.009	.065
2080/5.2	Big River near Desoto	2080	2001	K BASS	.08	0	.014
2080/5.2	Big River near Desoto	2080	2002	K BASS	LT .17	LT .06	.027
2074/20.0	Big R. @ Cedar Hill Access	2074	1986	L BASS			.050
2080/5.2	Big River near Desoto	2080	1994	L BASS	.160		.036
2168/4.5	Flat River Cr. just bl. Elvins TP trib.	2168	1998	L BASS			.074
2168/6.0	Flat River Cr. @ Derby, MO.	2168	1998	L BASS			.1
2080/5.2	Big River near Desoto	2080	1980	MIXED			.010
2080/65.7	Big River at Irondale	2080	1997	N HOG	LT .010	.0047	.054

[16] B RED = Black Redhorse; BASS = Black bass (LM, SM, KY); CH CAT = Channel Catfish; FH CAT = Flathead Catfish; G RED = Golden Redhorse.
Pb – lead; Cd – cadmium; Hg - mercury

Site	Site Name	WBID	YEAR	SPECIES [16]	Pb	Cd	Hg
2080/71.6	Big R. @ Bootleg Access	2080	1999	N HOG	0.004	LT .002	0.061
2080/5.2	Big River near Desoto	2080	1994	ROCK	.360		.033
2080/5.2	Big River near Desoto	2080	1995	ROCK	.110	.013	.026
2080/65.7	Big River at Irondale	2080	1997	ROCK	.052	.0041	.050
2074/20.0	Big R. @ Cedar Hill Access	2074	1998	ROCK	.030	.0097	.034
2080/5.2	Big River near Desoto	2080	1998	ROCK	.041	.014	.028
2080/5.2	Big River near Desoto	2080	1986	S BASS			.047
2074/20.0	Big R. @ Cedar Hill Access	2074	1987	S BASS	.083		.061
2080/5.2	Big River near Desoto	2080	1987	S BASS	.040		
2080/5.2	Big River near Desoto	2080	1995	S BASS	.110	.007	.011
2074/20.0	Big R. @ Cedar Hill Access	2074	1997	S BASS	.081	.011	.112
2080/5.2	Big River near Desoto	2080	1997	S BASS	.410	.012	.042
2074/20.0	Big R. @ Cedar Hill Access	2074	1998	S BASS	.1	.006	.06
2080/5.2	Big River near Desoto	2080	1998	S BASS	.05	.005	.035
2080/5.2	Big River near Desoto	2080	1999	S BASS	.308		.046
2080/5.2	Big River near Desoto	2080	1992	SH RED	.550		.024
2168/0.8	Flat River Cr. near mouth	2168	1996	SUCKER	.450	.019	.042
2168/6.0	Flat River Cr. @ Derby, MO.	2168	1996	SUCKER	.066	.0033	.035
2168/0.8	Flat River Cr. near mouth	2168	2000	SUCKER	.46	.016	.024
2080/71.6	Big R. @ Bootleg Access	2080	2001	SUCKER	0	.017	.021
2074/20.0	Big R. @ Cedar Hill Access	2074	1987	SUN	.130		
2080/5.2	Big River near Desoto	2080	1987	SUN	.440		
2080/5.2	Big River near Desoto	2080	1993	SUN	1.700		.019
2080/5.2	Big River near Desoto	2080	1994	SUN	.340		.036
2080/5.2	Big River near Desoto	2080	1995	SUN	.800	.024	.013
2168/0.8	Flat River Cr. near mouth	2168	1995	SUN	.560	.016	.059
2080/5.2	Big River near Desoto	2080	1996	SUN	.440	.016	.020
2168/0.8	Flat River Cr. near mouth	2168	1996	SUN	.500	.014	.079
2168/6.0	Flat River Cr. @ Derby, MO.	2168	1996	SUN	.030	.0031	.084
2074/20.0	Big R. @ Cedar Hill Access	2074	1997	SUN	.350	.014	.050
2080/5.2	Big River near Desoto	2080	1997	SUN	1.200	.038	.043
2080/65.7	Big River at Irondale	2080	1997	SUN	LT .020	.0071	.047
2168/4.5	Flat River Cr. just bl. Elvins TP trib.	2168	1998	SUN	1.4	.05	.052
2168/6.0	Flat River Cr. @ Derby, MO.	2168	1998	SUN	.7	.025	.07
2080/71.6	Big R. @ Bootleg Access	2080	1999	SUN	0.006	LT .002	0.039
2168/0.8	Flat River Cr. near mouth	2168	2000	SUN	.36	LT .006	.022
2168/6.0	Flat River Cr. @ Derby, MO.	2168	2000	SUN	.6	.009	.031
2080/71.6	Big R. @ Bootleg Access	2080	2001	SUN	0	.013	.021

Appendix H – Levels of Metals in Sediments (mg/kg)

ORG	SITE	SITE NAME	Date	Lead	Zinc
UMR	2074/10.2	Big R. @House Springs Access	19980000	966	487
UMR	2074/10.2	Big R. @House Springs Access	19980000	1100	315
UMR	2074/10.2	Big R. @House Springs Access	19980000	1609	647
USGS	2074/52.8	Big R. near Richwoods	19880224	2300	430
USGS	2074/52.8	Big R. near Richwoods	19890914	1800	560
MDNR	2074/52.8	Big R. near Richwoods	20031103		
MDNR	2074/52.8	Big R. near Richwoods	20031103	1170	380
Mean: 30+ Miles Below Old Lead Belt (OLB)				**1490.833**	**469.8333**
Sediment Guidelines: Probable Effect Level				82	540
MDNR	2080/8.5	Big R. @Washington State Park	20021002	486	157
MDNR	2080/8.5	Big R. @Washington State Park	20021002	300	159
MDNR	2080/8.5	Big R. @Washington State Park	20021002	374	137
MDNR	2080/13.4	Big R. downstream of Mill Creek	20021003	389	221
MDNR	2080/13.4	Big R. downstream of Mill Creek	20021003	297	129
MDNR	2080/13.4	Big R. downstream of Mill Creek	20021003	370	217
MDNR	2080/20.4	Big R. upstream of Mill Creek	20021002	437	491
MDNR	2080/20.4	Big R. upstream of Mill Creek	20021002	459	247
MDNR	2080/20.4	Big R. upstream of Mill Creek	20021002	657	367
UMR	2080/30.2	Big River 11.7 mi.bl. Flat River Cr.	19980000	2667	1944
UMR	2080/30.2	Big River 11.7 mi.bl. Flat River Cr.	19980000	720	709
UMR	2080/30.2	Big River 11.7 mi.bl. Flat River Cr.	19980000	2797	2032
NewFields	2080/32.4	Big River at St. Francois State Park	19990916	2061	1562
NewFields	2080/32.4	Big River at St. Francois State Park	20000901	5558	1574
MDNR	2080/32.4	Big River at St. Francois State Park	20020926	1990	383
MDNR	2080/32.4	Big River at St. Francois State Park	20020926	4180	306
MDNR	2080/32.4	Big River at St. Francois State Park	20020926	1320	728
Mean: 0-20 Miles Below OLB				**1474.235**	**668.4118**
Sediment Guidelines: Probable Effect Level				82	540
MDNR	2080/36.9	Big R. upstream of Bonne Terre	20020925	5820	445
MDNR	2080/36.9	Big R. upstream of Bonne Terre	20020925	886	645
MDNR	2080/36.9	Big R. upstream of Bonne Terre	20020925	2170	1110
UMR	2080/40.7	Big River 1.2 mi.bl. Flat River Cr.	19980000	4924	2755
UMR	2080/40.7	Big River 1.2 mi.bl. Flat River Cr.	19980000	3680	2746
UMR	2080/40.7	Big River 1.2 mi.bl. Flat River Cr.	19980000	3279	1585
NewFields	2080/41.9	Big River below Flat River	19990916	3961	2362
NewFields	2080/41.9	Big River below Flat River	20000901	2685	2977
MDNR	2080/41.9	Big River below Flat River	20020924	1250	695
MDNR	2080/41.9	Big River below Flat River	20020926	218	779
MDNR	2080/41.9	Big River below Flat River	20020926	645	637

ORG	SITE	SITE NAME	Date	Lead	Zinc
NewFields	2080/42.1	Big River near Hwy. 67	19990916	3168	3950
NewFields	2080/42.1	Big River near Hwy. 67	20000901	3335	3872
USGS	2080/42.5	Big River below Desloge	19880225	3800	1800
USGS	2080/42.5	Big River below Desloge	19890913	3500	4900
UMR	2080/42.5	Big River below Desloge	19980000	2837	4230
UMR	2080/42.5	Big River below Desloge	19980000	3236	4038
UMR	2080/42.5	Big River below Desloge	19980000	3432	3583
MDNR	2080/42.5	Big River below Desloge	20021001	4430	1700
MDNR	2080/42.5	Big River below Desloge	20021002	2360	1210
MDNR	2080/42.5	Big River below Desloge	20021002	3100	1500
UMR	2080/45.0	Big R. @Desloge Tailings Pile	19980000	3178	4004
UMR	2080/45.0	Big R. @Desloge Tailings Pile	19980000	3080	3632
UMR	2080/45.0	Big R. @Desloge Tailings Pile	19980000	4611	4180
NewFields	2080/45.0	Big R. @Desloge Tailings Pile	19990916	3623	3939
NewFields	2080/45.0	Big R. @Desloge Tailings Pile	20000901	2065	4764
USGS	2080/48.6	Big River @ Bone Hole	19880324	5800	4300
USGS	2080/48.6	Big River @ Bone Hole	19890914	4500	3000
UMR	2080/48.6	Big River @ Bone Hole	19990916	3694	3395
UMR	2080/48.6	Big River @ Bone Hole	19990916	4874	4792
UMR	2080/48.6	Big River @ Bone Hole	19990916	5863	5176
UMR	2080/48.6	Big River @ Bone Hole-A	19990916	3648	3175
UMR	2080/48.6	Big River @ Bone Hole-A	19990916	3388	3395
UMR	2080/48.6	Big River @ Bone Hole-A	19990916	6030	5293
NewFields	2080/48.6	Big River @ Bone Hole	19990916	4356	3954
NewFields	2080/48.6	Big River @ Bone Hole-A	19990916	4811	4454
NewFields	2080/48.6	Big River @ Bone Hole	20000901	1550	812
NewFields	2080/48.6	Big River @ Bone Hole-A	20000901	705	5251
UMR	2080/51.9	Big River @ Leadwood Access	19990916	10550	3628
UMR	2080/51.9	Big River @ Leadwood Access	19990916	10214	3662
UMR	2080/51.9	Big River @ Leadwood Access	19990916	1160	1452
NewFields	2080/51.9	Big River @ Leadwood Access	19990916	7308	2914
NewFields	2080/51.9	Big River @ Leadwood Access	20000901	2469	1980
MDNR	2080/55.6	Big R. 0.7 mi.bl. Eaton Br.	20021002	1970	3550
MDNR	2080/55.6	Big R. 0.7 mi.bl. Eaton Br.	20021002	670	1640
Mean: Within OLB				**3618.511**	**2974.689**
Sediment Guidelines: Probable Effect Level				82	540
MDNR	2080/56.4	Big R. 0.1 mi.ab. Eaton Branch	20031103	78.4	73
USGS	2080/65.5	Big River at Irondale	19880223	58	61
USGS	2080/65.5	Big River at Irondale	19890913	89	110
UMR	2080/65.5	Big River at Irondale	19990916	64.9	80.4
UMR	2080/65.5	Big River at Irondale	19990916	94.8	112.9
UMR	2080/65.5	Big River at Irondale	19990916	65.2	79.6

ORG	SITE	SITE NAME	Date	Lead	Zinc
NewFields	2080/65.5	Big River at Irondale	19990916	77.2	91
NewFields	2080/65.5	Big River at Irondale	20000901		106.3
MDNR	2080/65.5	Big River at Irondale	20021002	20.1	18.1
MDNR	2080/65.5	Big River at Irondale	20021002	15.8	17.9
MDNR	2080/65.5	Big River at Irondale	20021002	14.7	18.9
MDNR	2080/68.3	Big River just bl. Cedar Cr.	20010926	21	34.9
MDNR	2080/68.3	Big River just bl. Cedar Cr.	20010926	14.3	44.8
MDNR	2080/68.3	Big River just bl. Cedar Cr.	20010926	29.4	59.5
MDNR	2080/71.6	Big R. near Belgrade	20010926	18.2	25.5
MDNR	2080/71.6	Big R. near Belgrade	20010926	18.9	40.9
MDNR	2080/71.6	Big R. near Belgrade	20010926	16.9	35.5
MDNR	2080/73.4	Big R. DS of Clear Cr.	20010926	15.4	51.2
MDNR	2080/73.4	Big R. DS of Clear Cr.	20010926	17.3	24.4
MDNR	2080/73.4	Big R. DS of Clear Cr.	20010926	16	25
Mean: Upstream of OLB				**39.23684**	**55.54**
Sediment Guidelines: Probable Effect Level				82	540
MDNR	2166/0.05	Eaton Branch nr mouth	20031001	2490	2680
MDNR	2166/0.05	Eaton Branch nr mouth	20031001	1150	1730
MDNR	2166/0.05	Eaton Branch nr mouth	20031001	3090	1630
MDNR	2166/0.05	Eaton Branch nr mouth	20031103	2490	3910
Mean: Drainage from Leadwood TP				**2305**	**2487.5**
Sediment Guidelines: Probable Effect Level				82	540
MDNR	2168/0.8	Flat River Cr. nr. Mouth	20021009	2740	219
MDNR	2168/0.8	Flat River Cr. nr. Mouth	20021009	2660	254
MDNR	2168/0.9	Flat River just ab. WWTP	20031104	7220	155
UMR-Kra	2168/2.0	Flat River Cr.@ National CP	19750700	3140	862
USGS	2168/2.0	Flat River Cr.@ National CP	19880224	4200	610
USGS	2168/2.0	Flat River Cr.@ National CP	19890913	3100	460
UMR	2168/2.0	Flat River Cr.@ National CP	19980000	3584	1344
UMR	2168/2.0	Flat River Cr.@ National CP	19980000	4145	1528
UMR	2168/2.0	Flat River Cr.@ National CP	19980000	4549	2551
MDNR	2168/2.0	Flat River Cr.@ National CP	20010712	5870	193
NewFields	2168/2.2	Flat River Cr.@ National CP	19990916	4092	1808
NewFields	2168/2.2	Flat River Cr.@ National CP	20000901	5.94	1707
MDNR	2168/2.6	Flat River Cr.@ National CP	20010925	15400	547
MDNR	2168/2.6	Flat River Cr.@ National CP	20010925	763	160
MDNR	2168/2.6	Flat River Cr.@ National CP	20010925	7600	387
UMR	2168/3.9	Flat River just bl. Federal TP	19980000	2018	2580
UMR	2168/3.9	Flat River just bl. Federal TP	19980000	2970	3138
UMR	2168/3.9	Flat River just bl. Federal TP	19980000	2500	2688
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19980300	630	280

ORG	SITE	SITE NAME	Date	Lead	Zinc
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19980600	124	27.8
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19980700	311	299
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19981000	1802	388
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19990300	1380	264
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19990600	1640	631
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19990700	3610	435
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	19991000	6430	424
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	20000300	2980	292
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	20000600	3170	294
MDNR-DPHP	2168/3.9	Flat River just bl. Federal TP	20000700	4468	492
NewFields	2168/3.9	Flat River just bl. Federal TP	20000901	77.2	3318
MDNR	2168/3.9	Flat River just bl. Federal TP	20010925	3600	594
MDNR	2168/3.9	Flat River just bl. Federal TP	20010925	3970	282
MDNR	2168/3.9	Flat River just bl. Federal TP	20010925	1410	257
MDNR	2168/3.9	Flat River just bl. Federal TP	20031104	4060	588
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19980300	1830	1440
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19980600	257	45.7
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19980700	18.1	8.6
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19981000	133	101
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19990300	110	31.7
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19990600	584	64.7
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19990700	583	74.1
NewFields	2168/4.4	Flat River Cr.@Rivermines	19990916	1847	5925
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	19991000	604	415
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	20000300	457	356

ORG	SITE	SITE NAME	Date	Lead	Zinc
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	20000600	126	272
MDNR-DPHP	2168/4.4	Flat River Cr.@Rivermines	20000700	450	706
NewFields	2168/4.4	Flat River Cr.@Rivermines	20000901	6259	6295
MDNR	2168/4.4	Flat River Cr.@Rivermines	20031104	708	439
UMR	2168/4.5	Flat River just bl. Elvins TP trib.	19980000	1840	3639
UMR	2168/4.5	Flat River just bl. Elvins TP trib.	19980000	2076	9619
UMR	2168/4.5	Flat River just bl. Elvins TP trib.	19980000	1624	4516
MDNR	2168/4.5	Flat River just bl. Elvins TP trib.	20010925	2560	2660
MDNR	2168/4.5	Flat River just bl. Elvins TP trib.	20010925	1650	1870
MDNR	2168/4.5	Flat River just bl. Elvins TP trib.	20010925	142	548
Mean: Within OLB				**2594.023**	**1279.307**
Sediment Guidelines: Probable Effect Level				82	540
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19980300	795	37.5
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19980600	74	20.3
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19980700	28.6	160
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19981000	21.4	16.6
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19990300	81.6	43.4
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19990600	31.4	16.2
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19990700	31.7	21.3
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	19991000	162	43.1
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	20000300	270	82.2
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	20000600	287	107
MDNR-DPHP	2168/5.9	Flat River Cr.@Hwy B	20000700	114	139
MDNR	2168/5.9	Flat River Cr.@Hwy B	20010925	50.1	26.4
MDNR	2168/5.9	Flat River Cr.@Hwy B	20010925	166	64
MDNR	2168/5.9	Flat River Cr.@Hwy B	20010925	94.4	48.1
MDNR	2168/8.2	Flat River Cr. just bl. Dry Cr.	20010925	36.1	32.9
MDNR	2168/8.2	Flat River Cr. just bl. Dry Cr.	20010925	50.9	50.3
MDNR	2168/8.2	Flat River Cr. just bl. Dry Cr.	20010925	44.2	27.8
Mean: Upstream of				**137.5529**	**55.064**

ORG	SITE	SITE NAME	Date	Lead	Zinc
OLB					**71**
Sediment Guidelines: Probable Effect Level				82	540
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19980600	1014	24.3
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19980700	21700	378
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19981000	6035	377
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19990300	8230	403
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19990600	13500	825
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19990700	28900	576
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	19991000	6980	478
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	20000300	5770	415
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	20000600	5620	574
MDNR-DPHP	2170/0.6	Shaw Br. @ St. Joe S. P.	20000700	4965	487
Mean: Drainage from Federal Tailings				10271.4	453.73
Sediment Guidelines: Probable Effect Level				82	540